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**A Framework for Vacant Land Policy in Shrinking Cities**

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**Submitted for the Degree of Doctor of Philosophy**

**University of Edinburgh**

**School of Landscape Architecture/Edinburgh College of Art**

**2018**

## **DECLARATION**

### Declaration

I composed this thesis and the work is my own. No part of this thesis was submitted for any other degree or qualification.

Kurt Culbertson

May 24, 2018

## ABSTRACT

This thesis provides a theoretical framework for evaluating the causes of vacant land in shrinking cities. The focus of this thesis was New Orleans and St. Louis; these two cities were selected as the case studies because they are roughly of similar age, possess a common cultural and economic heritage, and have a geographic footprint which encompasses different environmental conditions. This thesis evaluated factors that contribute to patterns of land vacancy within these two cities. Factors included in this evaluation include employment and other economic and cultural opportunities, environmental and ecological conditions, social dynamics and conditions, governmental management decisions, and “quality of life” stressors, such as proximity to major infrastructure and industrial development. The theoretical framework described in this thesis is intended to apply to other shrinking cities beyond the case studies.

A geographic information system database using historical maps and population census data were created for each city and utilized to examine temporal patterns in the relationship between land vacancy and a variety of environmental, economic, and social factors. Maps from the time of the founding of each city were geo-referenced to create a depiction of the ecological conditions prior to European settlement at the sites of New Orleans in 1718 and St. Louis in 1764, respectively. Time-series data gathered from the United States population censuses were utilized to document spatial change of the two cities as they evolved.

*Homo sapiens* like other species compete for habitat. Access to high quality habitat within the urban ecosystem is determined by contestation between individuals and social groups, through market mechanisms and through management decisions, both utilitarian and ideological. Corruption and violence may also be factors. Individual agency is a factor in this contestation but social and cultural structures can also work to limit individual choices, particularly for minorities and low income residents, and relegate many residents to suboptimum or marginal habitat.



A data analysis of both New Orleans and St. Louis showed that the quantity and location of vacant land is primarily influenced by proximity to opportunities and by proximity to major risks which impact the quality of *Homo sapiens* habitat. The first of these is proximity to opportunities such as employment, education, and cultural resources. The second is the presence of natural hazards, such as flooding and geological hazards, as revealed by the analysis of the historical ecology of the city. The third is the impact of local government management decisions and social planning which has spatial implications, including racially-based zoning, racial covenants, redlining, and isolation from public services and facilities such as the segregation of public schools. These decisions are often the reflection of ideology and power relationships. A fourth driver of land vacancy is proximity to risks, notably industrial lands, but also the intrusion of major infrastructure projects such as the development of the railyards and rail corridor of St. Louis, the construction of the Industrial Canal in New Orleans, and the construction of Interstate highways through both cities. In some circumstances, such drivers that include the unintended consequences of utilitarian decisions. The fifth driver include socio-economic factors and the neighborhood effects of crime, and poor education. These five drivers act in different proportions in each city to influence land values which, in turn, drive levels of vacancy.

This comparative investigation revealed that the impact of geophysical factors on land vacancy varies greatly between New Orleans and St. Louis. While much of New Orleans lies below sea level and is often subject to flooding and hurricanes, little of the vacant lands of St. Louis are impacted by geophysical factors. In contrast, management decisions and social planning have contributed significantly to the concentration of poverty and, in turn, land vacancy in both cities. While some of these management decisions are utilitarian in nature and intended to provide the greatest benefits for the most number of people, others are ideologically driven or reflect power relationships and in the case of both New Orleans and St. Louis, racism. Proximity to risks, such as active railroad tracks, major highways, and industrial development, also has a strong relationship to land vacancy in both cities. Land vacancy also has a strong spatial relationship with areas of low income, poor education, and crime and neighborhood effects. While an understanding of environmental history can provide a useful guide to vacant land policy, efforts to address the challenge of vacant lands must

consider not only the symptoms but the underlying causes of vacancy, particularly economic and social factors.

This thesis is addressed to planners, architects, urban designers, landscape architects, and elected and appointed government officials who work to address the challenges of shrinking cities. Though this thesis examined the causes of vacant land in two shrinking cities, future research should examine the application of the theoretical framework presented here to cities experiencing growth as well.

## ACKNOWLEDGEMENTS

I come from a long line of academicians where scholastic achievement is not only desirable but expected. This thesis, therefore, is the culmination of a lifetime search for knowledge instilled by my great extended family. Specifically, this work owes its inspiration to my mother, whose love of learning inspired Louisiana school children for twenty-five years until her career was cut short by health issues, and to my father, whose insatiable curiosity about everything taught me to seek the connection among seemingly disparate bodies of knowledge.

To my colleagues in the academic community – Dr. Lake Douglas, Dr. Fritz Steiner, Dr. Chris Marsh, Dr. Steven Apfelbaum, and Anne Whiston Spirn- I owe a great gratitude for their inspiration and support. The critique of my thesis examiners, Dr. Tahl Kaminer and Dr. Carl Steinitz was particularly valuable. To my academic advisor at the Edinburgh College of Art, Dr. Catharine Ward Thompson, Professor of Landscape Architecture and Director of the OPENspace Research Centre, I will be forever grateful for her guidance along the path of academic research, her insight, and her ability always to ask the tough questions.

To my professional colleagues at Design Workshop – I encourage you to continue to blur the lines between practice and the academy and to continue to pursue ways to conduct research in the context of practice. It is only through asking beautiful questions that we can innovate.

Finally, my greatest thanks go to my wife, Gene Anne, without whose love and support this work would have never been completed, and to my daughters, Erin and Sarah, who gave me the hope and trust in the future needed to undertake this long journey.

## **BIOGRAPHICAL PROFILE**

Early in my career, I worked on a variety of projects in Brazil, where Design Workshop maintained an office in Sao Paulo. I was fascinated with the prospects of the Rio Tietê, the river that flows through the city. On each visit my route from the airport into the heart of the city followed the Rio Tietê, a river bounded and channelized between major highways. I often wondered how Sao Paulo might have become a different city if it had built in a manner compatible with the natural environment instead of dramatically modifying the landscape. If we only understood and followed the principles of environmental design and planning when the world's cities were initially created, I thought, how would they be different today? This question has been a fascination for forty years.

For much of my career, my work focused upon the design of private sector real estate, including master planned communities, mixed use urban development, and brownfield redevelopment. With the coming of The Great Recession of 2008, almost all private sector development work in the United States ceased, requiring me to refocus my work and shift largely to public sector projects. The highlights of this post-recession work included the master plan for the Lafitte Greenway in New Orleans. The greenway was created by converting the abandoned lands of the New Orleans railyards which ran through seven neighborhoods, including Tremé, the oldest African American neighborhood in the United States. It is an area that historically was chronically underserved by parks and subject to a great deal of land vacancy. A challenge was to enhance the quality of life of area residents without contributing to gentrification. The Lafitte Greenway has become a tremendous new addition to the city's park system, addresses stormwater management along the corridor, and has generated over \$200 million dollars in new investment in the three years since it opened. Hoped for employment for residents along the corridor, however, has yet to be realized. Although recreational opportunities are improved, how this improvement will impact the adjacent neighborhoods economically and socially has yet to be determined. Similarly, the impact on land vacancy has yet to be determined. This work does suggest that neighborhood transformation requires a more multi-pronged approach than just open space planning and design. How can spatial equity – equitable access to opportunities and equitable freedom from risks to insured for all residents?

In addition to my work in New Orleans, several projects in the St. Louis, Missouri, region including revitalization plans for South Grand Boulevard, Manchester Road, and Dorsett Road and transit-oriented development assessments for the 37 light rail stations of the MetroLink system offered similar experiences. South Grand is an arterial street expanded over time to carry suburbanites through the city. As traffic volumes and speeds increased the street divided neighborhoods, fragmenting human habitat, resulting in the decline of neighborhood serving retail and increasing land vacancy. The adjacent neighborhoods have become diverse ethnic neighborhoods where new immigrants to the city settle. The design challenge was to right-size the street, re-link adjacent neighborhoods and increase economic development.

The assessment of Metro's light rail stations included the evaluation of stations in North St. Louis, an area with substantial publicly owned vacant lands, and the adjacent communities of Wellston and East St. Louis, two communities with large African-American populations, extreme poverty, and substantial land vacancy. Like St. Louis to the west, East St. Louis is a shrinking city. The population of East St. Louis is ninety-eight percent African-American and over forty percent of the city's land area is vacant. Wellston is ninety-two percent African-American and contains significant vacant lands. Both Wellston and East St. Louis contain numerous brownfield sites. This work challenged the design team to understand the causes of land vacancy and to contemplate possible solutions.

This work provided a strong working knowledge of the physical context of two shrinking cities, New Orleans and St. Louis, as well as, the current economic and social conditions. More recent work in northwest Detroit has furthered my understanding of vacant lands. Like New Orleans and St. Louis, Detroit has substantial quantities of publicly owned vacant land and persistent poverty. There is no shortage of parkland, though improvements and maintenance are lacking. Numerous efforts to convert vacant lands to urban agriculture have enhanced the quality of life but have not significantly reduced vacant lands or improved the economic condition of residents. Extensively public engagement with the community, demonstrated the strong desire for employment opportunities and neighborhood serving retail. While working in these cities, I was moved by the plight of the poor of both cities, and by the difficult conditions in which they live. These experiences, led me to co-found the Environmental Justice Professional Practice Network of the American Society of

Landscape Architects. We face no greater challenge as designers than providing spatial equity to our fellow citizens.

This thesis utilizes the knowledge gained from those experiences to assess a theoretical framework to understand the causes of vacant land in New Orleans and St. Louis and seeks to understand how an understanding of the environmental history of these cities might be utilized to transform these cities today. Although the focus of this work is on vacant land policy in shrinking cities, I am currently applying the methodology developed in this research to ongoing work in Vancouver and Houston to understand how this methodology might also apply to growing cities as well. I believe that there is great potential through this methodology to apply an ecology “of” the city which goes beyond current efforts in the design professions to reconcile ecology “in” the city.

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## CHAPTER 1: INTRODUCTION

### 1.1 PROLOGUE: THE SHRINKING CITY

Throughout history some cities have lost population while others have continued to grow. Shrinking cities are found on every continent, and today, one sixth of cities with populations of over 100,000 throughout the world are losing population (Beyer, et al, 2006). One third of European cities, regardless of size, lost population from 1996 to 2001 (Wolff, 2010), and the magnitude of this population change is significant. In Scotland, for example, Glasgow's peak population was 1,088,000 in 1931. Today it has a population of 577,869. Even in China, the global leader in economic expansion during much of the last decade, there are hundreds of former mining and industrial cities that are losing population (Figure 1).



Figure 1: Distribution of Shrinking Cities Worldwide

The reasons for this population loss are varied (Stansel, 2011). Some cities have been destroyed by natural disasters. Others, dependent upon declining industries,

including the textile mill villages of the United Kingdom and the steel towns of the American Midwest, have failed to compete in the shifting global economy. In others, such as Halle and Leipzig in Eastern Europe, the collapse of the state economy has led to dramatic decline (Reiken and Martinez-Fernandez, 2011). Today one in six cities in the world with populations larger than 100,000 is losing population (Beyer, et al, 2006).

To characterize shrinking cities only by their loss of population would be an oversimplification. At least six indicators have been identified for such cities (Wolff, 2007): population development (including total population and population density); net-migration rates; development of jobs; unemployment rates; property taxes per head; and purchasing power per head. Population decrease is often caused by a loss of jobs and increase in unemployment rates, which in turns leads to reduced public investment, a decline in economic prosperity, and a fall in purchasing power and property taxes per head and property taxes.

With a fraction of the former tax base resulting from decreasing populations, civic leaders must still maintain infrastructure and provide services to a region far greater than the area required to serve a city's current population. Though the population of Buffalo, New York, for example, has declined from its 1950 peak of 580,132 to 279,745 today, the land area of the city remains substantially the same.

Forty years ago, in Detroit, the greatest distance a police cruiser had to travel to a home was three miles. Today, that distance is now seven miles. Similar demands are placed upon a community's education system as well. Administrators must determine how and where to prioritize resources.

In a sense, the ecological footprint of shrinking cities has shrunk. An ecological footprint is the total amount of the earth's surface needed to support a given city's level of consumption and absorb its waste products (Rees and Wacknagel, 1994). While even shrinking cities may still have an ecological deficit (its demand for goods and services exceed what its land can provide), decision-makers, are nonetheless challenged to determine how to manage this smaller ecological footprint.

Vacant lands may provide the opportunity to shape the city in new more sustainable ways.

Faced with such challenges, civic leaders can choose one of four courses. The first course of action is to ignore the issue in the belief that the forces of the market will eventually correct the problem. The second course of action is to accommodate the problem by treating the symptoms. This often takes the form of anti-flipping efforts, demolition, brown-field redevelopment, land banks, and building moratoria. Abusive home "flipping" occurs when a property is resold for a large profit at an artificially inflated price immediately after being acquired by the seller with little or no improvements to the property. Predatory lending happens when unsuspecting homebuyers either pay a price far higher than its fair market value or commit to a mortgage at unjustly inflated interest rates, closing costs or both. The third course of action is to combat decline by exploiting new opportunities, often through re-greening efforts, gardening collectives, tax abatements, deregulations, and increased code enforcement. Increasingly, some cities are embracing the fourth option and seek to accomplish revitalization without growth. The goal is to shrink the city's geographical dimensions to a level that is balanced to the city's existing or potential population. Techniques utilized include strategic planning, a triage or targeted investment strategy, relocations, decommissioned infrastructure, and planned abandonment.

Accomplishing such change can, however, be political suicide for elected public officials. Obligations, such as commitments to public work unions, assumed during times of plenty, are difficult to roll back in times of scarcity. The perception of a city's decline can also lead to stigmatization and demoralization of the populace. Civic disengagement often follows. In turn, negative perceptions and images lead to further disinvestment in a continual spiral of civic decline.

In the United States, a strong cultural commitment to self-determination and to the ideal of continual economic growth makes implementing radical action difficult. Mayors are faced with the belief that strong cities grow and weak cities shrink. One can imagine the political difficulty of simply abandoning entire sections of a city and no longer providing infrastructure and services. The heated reaction to New Orleans'

famous “Green Dot” map (Figure 2) following Hurricane Katrina, which suggested that some existing neighborhoods not be rebuilt, is evidence of the political challenges inherent in such an approach.

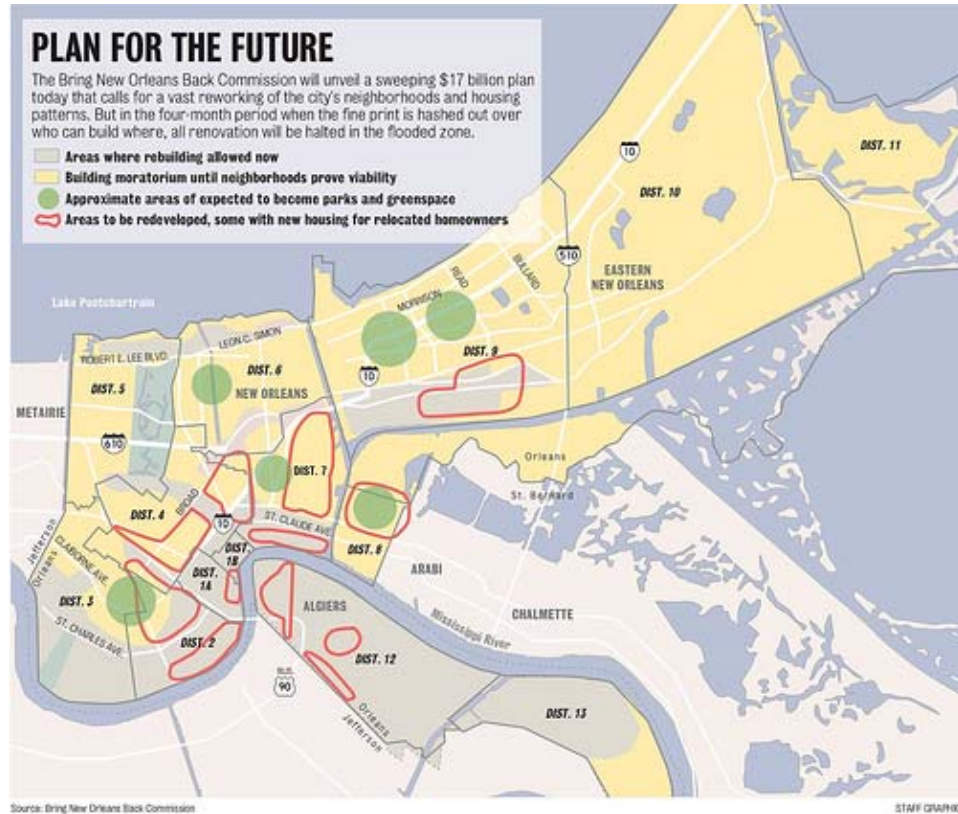


Figure 2: Urban Land Institute “Green Dot” Map

In a similar way, reaction to Paul McKee’s plans for 1500 acres of the Near North Side of St. Louis have also been controversial (Barker, 2018). Perhaps more importantly, a city must collectively come to grips with negotiating the memories of its past grandeur with its new reality. Evidence would suggest that many cities shrink for a while only to re-emerge later in different ways. A decision to abandon or demolish entire sections of a city requires a determination that a city will not begin to grow in the foreseeable future.

Weisman offers, in The World Without Us (Weisman, 2007), a vision of how natural systems would regenerate in the absence of *Homo sapiens* and how quickly all traces of *Homo sapiens* settlement could disappear from abandoned urban environments. Weisman's description reminds us of how dependent our urban systems are upon on-going maintenance. While the transformation of existing cities into wilderness appears imponderable, one must consider the useful life of urban infrastructure. While there is no universal agreement on the useful life of such infrastructure, some studies suggest that urban roadway, water, and utility systems have a useful life of 100 years or less (Topkins, 2008). If so, there is both the requirement and the opportunity to rebuild the infrastructure of an entire city within a few generations or conversely to abandon it at the end of its useful life. Urban researchers are increasingly focusing on the inequitable distribution of capital and maintenance budgets within American cities (PolicyLink 2012). These inequitable expenditure patterns, based on population, race, and class, further reinforce patterns of prosperity and decline. These concerns have led to the growth of equity mapping as a planning tool.

Even if political leadership has the courage to address such trends directly, the profession of planning and its literature provide little guidance in dealing with these difficult questions. Planning models primarily focus on managing growth and new development through traditional tools such as comprehensive planning, zoning, subdivision regulations, and urban growth boundaries (Dawkins and Nelson 2003). Planning for shrinkage is fundamentally different from planning for growth (Rybczynski and Linneman 1999), and thus far, the planning profession has not dealt with this phenomenon as extensively as it has with studies of managing growth.

Land planners accustomed to designing for growth are ill-prepared to manage the shrinking metropolitan areas in creative and thoughtful ways. A variety of potential solutions have been put forth ranging from utopian communities to the return of vacant land to agriculture and the creation of artistic interventions (Vinnitskaya, 2012). However, formalized processes for addressing these issues have yet to be adopted (Alsop, et al, 2006).



Environmental considerations, when suggested as a basis for creatively shrinking urban areas, are primarily put forth as techniques for greening the existing city form, but there is great potential to utilizing the underlying ecological conditions of the city – its topography, hydrology, vegetation, and geology – to provide a guiding framework for restructuring the city. Uncovering these underlying environmental systems can be difficult in places where centuries of urban development have often ignored or obliterated the underlying natural systems and the resulting landscape. This thesis initially sought to understand how knowledge of environmental history can form the basis of vacant land policy as a tool for a city's future. It soon became clear that geophysical factors were only one set of considerations in establishing a framework for understanding land vacancy. A broader examination of the causes of land vacancy in shrinking cities followed.

Vacant land for this study is defined as publicly owned parcels without existing buildings. These are lands which generally came into city ownership due to tax delinquency rather than publicly owned parcels which were purchased for a specific purpose such as parks and open space. The analysis considers two 18<sup>th</sup> century Mississippi River cities with French origins: New Orleans and St. Louis. The project utilized data and geographic information system mapping and analysis to examine the implication of underlying ecological systems for future land use and city form (Kuiper, 1999).

A data analysis of both New Orleans and St. Louis has shown that the quantity and location of vacant land is primarily impacted by five major factors:

1. The first of these is the presence of opportunities including employment, transportation, education, and cultural resources.

2. The second of these is the presence of natural hazards such as flooding and geological hazards as revealed by the analysis of the historical ecology of the city.

3. The third is the impact of management decisions which have spatial implications, including racially-based zoning, racial covenants, redlining, and isolation from public services and facilities such as the segregation of public schools. Social risks also include the neighborhood effects of crime, poor education, and other social factors.

4. A fourth driver of land vacancy is risk. For this thesis risk is defined as proximity to environmental stressors, notably industrial lands, but also the intrusion of major infrastructure projects such as the development of the railyards and rail corridor of St. Louis, the construction of the Industrial Canal in New Orleans, and the construction of Interstate highways through both cities.

5. A fifth driver of land vacancy is socio-economic factors including the neighborhood effects of crime and poor education.

The development of a strategy for managing vacant lands is particularly timely. If the causes of publicly owned land vacancy can be identified, planners, architects, landscape architects, urban designers, and elected and appointed officials can be more effective in meeting the challenge.

## **1.2 THE PROBLEM DEFINITION**

Given the complexity of cities with shrinking populations, where should one begin to address the planning and design challenge? Consideration of all solutions must seek to avoid unintended consequences. It is also clear that solutions must be effective across a variety of time scales, as solutions must have near-term benefits for current residents yet must also address long-term structural issues as well. Solutions must seek to modify path dependencies and be mindful of economic,

environmental, social, and institutional dependencies. Solutions must also incorporate concepts of resiliency so that the new direction for a city's evolution does not create new inefficient path dependencies or create environments that do not contribute to the health and well-being of a city and its residents. Landscape architects and planners can be viewed in this sense as restoration ecologists who are seeking to renew and restore degraded, damaged, or destroyed ecosystems and habitats in the environment by active *Homo sapiens* intervention and action. Hall and her colleagues defined habitat as the resources and conditions present in an area that produce occupancy-including survival and reproduction-by a given organism. Habitat quality is in turn defined as the ability of the environment to provide conditions appropriate for individual and population persistence (Hall et al 1997). Viewed from this perspective, design is the process of creating quality *Homo sapiens* habitat.

### **1.3 RESEARCH AIMS AND OBJECTIVES**

The overarching aim of this research is to develop a framework for understanding the causes of land vacancy in shrinking cities. Such an understanding might provide an ecological framework for vacant land management in shrinking cities. Historical ecology is focused on the interactions between *Homo sapiens* and their environment over long-term periods of time (typically centuries). The term *Homo sapiens* is used throughout this thesis to emphasize man as a biological organism and an integral part of nature rather than man apart and separate from nature. By considering *Homo sapiens* as part of nature rather than separate from nature, the actions of *Homo sapiens* over time in shaping the city were components of historical ecology.

Furthermore, this thesis has outlined several specific objectives:

1. Develop a framework for determining habitat quality for *Homo sapiens* and examine the relationship between habitat quality and land vacancy.

2. Synthesize available literature on urban patch dynamics and apply it to the built environment to understand if *Homo sapiens* are impacted by patch dynamics like other species.

3. Determine if a failure to build in concert with the natural environment has contributed to the persistence of low quality habitat patches that do not support *Homo sapiens* health and well-being and thereby contribute, over time, to the creation of vacant lands.

#### **1.4 RESEARCH QUESTIONS:**

To meet the aims of this research and achieve the objectives, this thesis seeks to answer a central question: What are the factors that contribute to land vacancy in shrinking cities? This question nests within a broader issue: how has a failure to build in concert with nature impacted the resiliency and sustainability of shrinking cities? Understanding this broader question provides the context for seeking answers to the central question.

In addition, this thesis aims to answer the following sub-questions with the support of the selected theories and methods:

1. What are the drivers of land vacancy in shrinking cities?
2. How might the physical form and infrastructure of a city be balanced or adjusted to its contemporary population?
3. Are property values an indicator of habitat quality and in turn land vacancy?

#### **1.5 THESIS STRUCTURE**

Chapter One has identified the research problems and a general strategy to address the issues uncovered. Chapter Two discusses the selection of the two case study cities, New Orleans and St. Louis. This chapter outlines the main reasons for the selection of these two cities and then describes and compares their fundamental characteristics. Chapter Three discusses the ecological principles and theories applied in the research and identifies gaps in to-date knowledge of the topic researched. Chapter Four outlines the research strategy, design, and methodology selected for investigation. Chapter Five describes the data collection process and the associated challenges with assembling time-series data over the almost-three- hundred-year history of New Orleans and St. Louis. Chapter Six presents the data analysis and the findings of the study. Chapter Seven draws together the findings in order to answer the posited research questions. It also discusses the used methodology, points to the contributions of this thesis to research knowledge, the limitations of the research, and the opportunities for future research. The appendix provides detailed environmental histories of both New Orleans and St. Louis, a compendium of sources of historical maps used in this study, as well as a description of demographic sources from the United States census.

## **CHAPTER 2: CASE STUDY CITIES**

### **2.1 THE CRITERIA FOR SELECTION OF CASE STUDY CITIES**

The previous chapter introduced the main issues to be explored in this thesis. To explore the factors that influence land vacancy, two cities were selected as case studies. New Orleans and St. Louis offered an appropriate context to give reliable and relevant information and to provide the possibility for comparison. The following criteria were developed for selection of case study cities:

1. Cities should be major cities within the United States that have experienced substantial loss of population over an extended period.
2. Cities should have similar cultural and economic situations but different environmental conditions to highlight the importance of geophysical conditions to the development and decline of both cities.
3. Case study cities should have available base data for analysis and existing environmental histories as a starting point for research.

Resources limited this study to two case studies. In the future, it would be useful to compare New Orleans and St. Louis to a growing city in order to better differentiate between factors that contribute to growth and decline.

### **2.2 DESCRIPTION OF THE CASE STUDY CITIES**

Based upon these criteria, two shrinking cities, New Orleans and St. Louis, were selected as case studies for this research (Figure 3). Weaver and his colleagues

identified 31 cities in the United States which they classified as already shrinking. These are cities that lost 25 percent of their population between 1970 and 2010.

Their projections further identified 22 cities that they projected would lose an additional 25 percent of their population by 2040 (a 25% loss of population between 2000 and 2040). Only 16 cities appear on both lists, including New Orleans and St. Louis (Weaver, Bagchi-Sen, Knight, and Frazier, 2017).

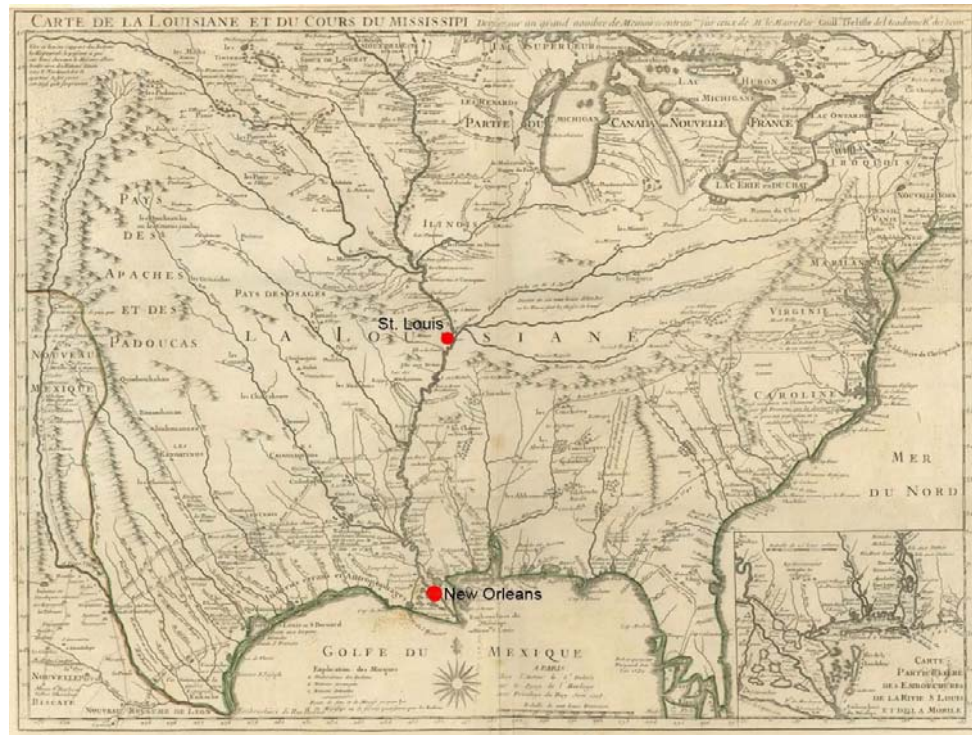


Figure 3: Map of the United States locating St. Louis and New Orleans 1800

As cities founded by the French and situated on the Mississippi River, New Orleans and St. Louis are of roughly comparable age. The economy of both cities has been closely tied through history to Mississippi River commerce. However, both occupy very different topography and climatic conditions. This common cultural and economic heritage allows for comparison between the two cities, while the differences in environmental conditions allows for the impact of historical ecology to be examined in contrast.

These two cities were also selected because of the availability of base data for analysis and the quality of existing environmental histories. Detailed environmental histories of New Orleans and St. Louis are found in the Appendix.

The resource limitations of this study did not allow a third case study. Had resources permitted, Detroit would have been selected as the third case study city. Located on the Detroit River, Detroit was founded by the French in 1701. Like New Orleans and St. Louis, Detroit's city boundaries are inelastic. Cities with inelastic boundaries cannot expand their boundaries through annexation to capture new development on the perimeter of the city. Detroit offers cultural and economic similarities to New Orleans and St. Louis yet a third environmental setting for consideration.

Alternatively, the use of a growing city as a third case study may have highlighted the factors that contribute to land vacancy in shrinking cities. However, growing cities typically do not possess the vast quantities of city-owned vacant land found in New Orleans and St. Louis, making comparison difficult. The use of a shrinking city in an economic system other than capitalism and a political system other than democracy might also highlight whether the causes of land vacancy found in New Orleans and St. Louis are also at work in other economic and political systems. A case city outside the United States would also provide an understanding of the impact of racism on publicly owned vacant land in another culture.

### **2.3 A COMPARISON OF THE CASE STUDY CITIES**

Both New Orleans and St. Louis were founded on the banks of the Mississippi River by French explorers in the 18th century (New Orleans in 1718, St. Louis in 1764). As French settlements, both utilized the arpent system of land survey and measurement in their early development which contributes to their distinctive forms



(Campanella, 2002), and each originally was laid out as *bastide*, replicating French colonial patterns of military installations (Figure 4).

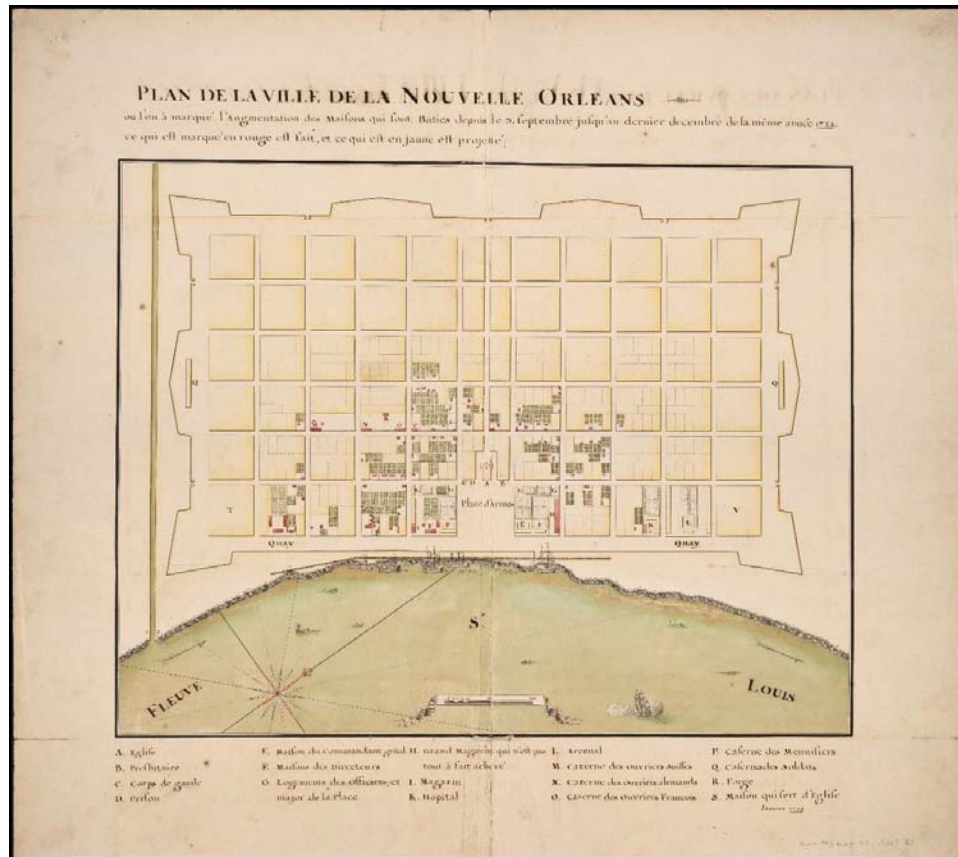


Figure 4: 1723 Map of the City of New Orleans

Both cities became part of the United States in 1803 as part of the Louisiana Purchase. Louisiana became a state in 1812, Missouri in 1821. Because of their similar age, there is not a dramatic difference in the time-scale of analysis. The City of New Orleans reached a peak population of 627,525 in 1960 but has declined by 45.2% to its 2010 population of 343,829. The City of New Orleans is coterminous with Orleans Parish and occupies 169.42 square miles with a population density of 2029.4 people per square mile. St. Louis reached a peak population of 856,796 in 1950 and subsequently declined by 62.7% to its 2010 population of 319,294. The City of St. Louis occupies a land area of 61.91 square miles with a population density of 5,157.5 people per square mile.

The points of peak population and the period of decline of these two cities are quite similar. An examination of vacant land in both cities during periods of greatest growth may provide valuable insights regarding the causes of land vacancy, but unfortunately data on vacant lands during these periods is not available making analysis impossible.

There are numerous historical accounts of the early years of both cities, as well as excellent historical map collections documenting their growth. As the first American census was conducted in 1790, demographic data is available for both cities for much of their histories, although as census gathering became more sophisticated over time, the United States Census Bureau gathered different information with successive censuses, making it difficult and at times impossible to extract directly comparable data over time.

One difference between the two cities is climate. New Orleans sits in a humid sub-tropical landscape with generally mild winters and hot, humid summers. The average precipitation is 159.26 centimeters (62.7 inches) a year, and there are, on average, 119 days a year with precipitation. It is rare for the temperature to top 37.78 degrees Celsius (100 degree Fahrenheit) or drop below -3.89 Celsius (25 degrees Fahrenheit). Snowfall is extremely rare. The wind is most often out of the south east (15% of the time), east (15% of the time), south (14% of the time), and north (13% of the time). Hurricanes are a major threat to New Orleans. The development of New Orleans follows the general pattern of uphill (higher elevation), upstream, with preferred residential neighborhoods generally located on the higher elevations on the nature levee of the river and generally upriver. An anomaly compared to the pattern found in many cities, these neighborhoods are generally downwind of the prevailing winds, perhaps because hurricanes generally arrive from the south and east across the Gulf of Mexico, thus making this portion of the city less prone to storm surge. There is no direct evidence to demonstrate how prevailing winds influenced the development of the city but New Orleans generally has an incidence of asthma higher than national averages. Much of this is attributed to indoor air quality and the formation of mold, common in the areas of

the city that are subject to flooding. Studies have suggested that epidemics of asthma in the city are most common when winds are from the south and southwest (Lewis, 1962; White, 1997).

St. Louis has a continental climate with strong seasonal changes of weather. As in New Orleans, temperatures rarely top 37.78 degrees Celsius (100 degrees Fahrenheit). There are on average 110 winter days below 0 degrees Celsius (32 degree Fahrenheit). Light snow falls on 13% of precipitation days. Average precipitation is 98.425 centimeters (38.75 inches) a year. Wind is most often out of the south (13%) and west (13%) which has had an influence upon the urban development pattern of the city. The preferred residential neighborhoods on the west side of St. Louis are uphill, upstream, and upwind from the rest of the city. With the prevailing winds from the west, the industrial districts of the city are in north St. Louis and across the Mississippi River in East St. Louis where wind would carry smoke and other pollutants away from prime residential areas.

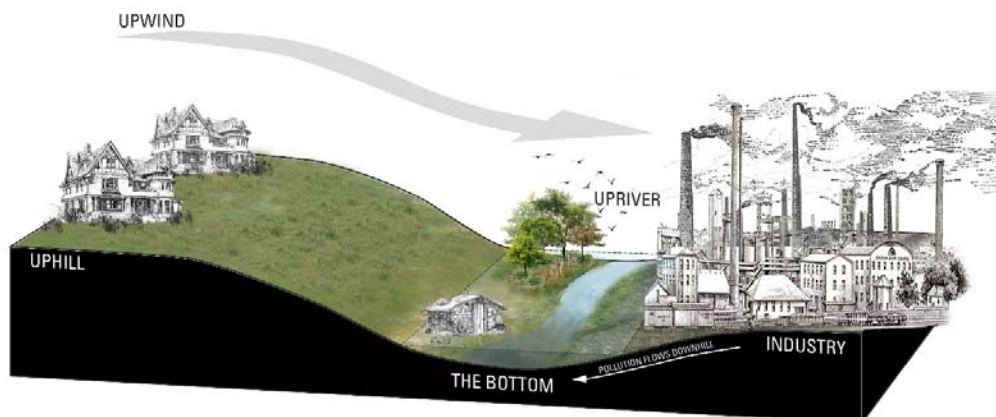


Figure 5: Uphill, Upriver, Upwind

The St. Louis metropolitan area has a history of tornadoes. The third deadliest and the costliest tornado in United States history, the 1896 St. Louis – East St. Louis tornado, injured more than one thousand people and caused at least 255 fatalities in the cities of St. Louis and in East St. Louis. The second costliest tornado also occurred in St. Louis in September, 1927. More tornado fatalities have occurred in St. Louis than

in any other American city. The invention of radar in 1935 provided scientists with the tools to track tornadoes, and the first radar system was deployed in the United States in 1940. Its first application to meteorology was in 1946. As with the sciences of geology and hydrology, often the knowledge needed to plan in concert with these environmental factors did not exist in the early evolution of New Orleans and St. Louis (Duda, 2016).

In a similar way, New Orleans has a storied history of hurricanes, most recently Hurricane Katrina in 2005, the deadliest natural disaster in American history with at least 1,245 persons killed and property damage estimated at \$108 billion. Louisiana has been hit by 49 of the 273 hurricanes that made landfall on the American Atlantic Coast between 1851 and 2004. In addition, 18 of the 92 major hurricanes with Saffir-Simpson ratings of category 3 or above have struck the state (United States mainland hurricane strikes by state, 1851-2004). On average, one major storm crosses within 100 nautical miles of New Orleans every decade. When a disturbance can be characterized by extent, spatial distribution, frequency, and by recurrence interval, it is termed a disturbance regime. Clearly the disturbance regime of the New Orleans ecosystem is defined by hurricanes.

Both St Louis and New Orleans are in slave states of the antebellum American South, resulting in correspondingly similar social dynamics. Racial zoning, deed restrictions, red-lining, the segregation of public schools, and other management techniques strongly reinforced geophysical conditions that placed the poor and people of color in harm's way. It is worth noting that such strategies were not exclusive to these communities and, in fact existed in communities throughout America in greater or lesser degrees well into the twentieth century. St. Louis considered a racial zoning ordinance in 1916. New Orleans passed a racial zoning ordinance in the 1920s but it did not survive a court challenge (Taylor, Hill, 2000). Lenders in both New Orleans and St. Louis, as in most American cities in the 1930s, also practiced red lining (University of Richmond, 2016). In both cities, this created issues of environmental and spatial justice that endure to this day.

Both cities have inelastic boundaries and are legally prohibited from expanding their boundaries through annexation. Some research has shown that cities with inelastic

boundaries are more likely to be shrinking cities than those with elastic boundaries (Weaver, R., 2016). The Missouri legislature fixed the boundary of St. Louis in 1876. During the Reconstruction period following the American Civil War, New Orleans (which was consolidated with Orleans Parish in 1805) gobbled swaths of adjacent Jefferson Parish, including the cities of Lafayette, Jefferson City, Algiers and Carrollton. In response to these aggressive annexations, in 1874 the Louisiana legislature prohibited New Orleans from annexing land by petition, election, or ordinance, from annexing any portion of Jefferson, Plaquemine, or St. Bernard Parishes, and from annexing any land owned by a publicbody (Hebert, 2015). The result set the boundaries of New Orleans at the city's 1874 limits (Courreges, 2013).

The area around present-day St. Louis, also known as Mound City because of the preponderance of ancient Native American earth structures, was also home to Cahokia, the great Native American city, and the largest *Homo sapiens* settlement between the deserts of Mexico and the Arctic. Located just across the Mississippi River from modern St. Louis and at its cultural peak between 1050 and 1200, Cahokia is estimated to have had a population of 10,000-20,000, larger at the time than that of Paris, the largest city in what is now Europe. At 1,618.74 hectares (4,000 acres), Cahokia, now uninhabited, is the largest archaeological site in North America. The Cahokia community of 1200 C.E. was not surpassed in population by another North American city until the late 18<sup>th</sup> century.

Perhaps indicative of the quality of the site of New Orleans for a city, there was little permanent settlement by native Americans. Instead, the region now occupied by urban communities was populated by loose confederations of migrating tribes of native Americans who subsisted on wildlife and vegetation from the swamps and marshes.

Although similar in some regards, New Orleans and St. Louis differ in their environmental settings as well as in the economies upon which the cities were built and this difference provides interesting opportunities for comparing these two communities and contrasting their urban evolution. The domain of this research,

therefore, considers at the landscape scale two shrinking cities over their roughly 300-year existence.

## **2.4 KEY CONCLUSIONS**

The most interesting similarity of New Orleans and St. Louis is that they are both shrinking cities that have been losing population over a long period. Both have received considerable media attention for their economic and social challenges. Both have experienced significant racial conflict over their histories and racial issues remain a significant concern in both cities. Vacancy of both land and buildings is a substantial issue in both New Orleans and St. Louis. In 2012, the percentage of vacant buildings in New Orleans ranked first among American cities for highest building vacancies in the United States. St. Louis was 22<sup>nd</sup> on this same list. Both cities have given considerable attention to their efforts to manage publicly owned vacant lands with mixed success. This research is, therefore, timely for both New Orleans and St. Louis and for other cities facing similar challenges of land vacancy.

## CHAPTER 3: FRAMEWORK AND AREA OF THESIS

### 3.1 WHY CITIES SHRINK

To address the challenges of shrinking cities and their vacant lands, one must first understand the cause of urban decline. Throughout history the forces of decline have been many and varied (Stansel, 2011). Some cities, such as Pompeii, have been destroyed by natural disasters. From an ecological perspective, the loss of these cities may be considered local extinction events. In a local extinction event, a species population ceases to exist in the area of study but may exist elsewhere. In recent history, Hurricane Katrina accelerated a period of population decline in New Orleans, although not a local extinction.

Many cities lose population due to changing economic fortunes. Some have outstripped the natural resources upon which they depended (Diamond, 1997). The textile mill villages of the United Kingdom and the steel towns of the American Midwest, which were dependent upon declining industries, failed to compete in the shifting global economy and have declined in population. Such economic decline may be considered the degradation of *Homo sapiens* habitat.

It has been suggested (Benson, 2009) that climate change was a contributing factor in the 13<sup>th</sup> century decline of Cahokia near present-day St. Louis, as warming temperatures and increased rainfall led to the flooding of traditional hunting and farming grounds. The return of mega-floods to the St. Louis region in 1200 A.D. resulted in habitat degradation making the ancient native American city of Cahokia marginal for continued *Homo sapiens* habitation (Munoz, 2015). A contemporary simulation of megafloods on the Mississippi and Missouri Rivers illustrates how the bottomlands of St. Louis would be inundated (Figure 6). It is anticipated that climate change will lead to the decline of many of the world's current coastal cities like New Orleans as sea levels rise.



Figure 6: Simulated Megafloods on the Missouri and Mississippi Rivers

Some cities have fallen victim to shifting trade patterns. In a similar way, changing modes of transportation have reduced the economic significance of many river and railroad towns. For example, the creation of the Interstate highway system in the United States in the 1960s shifted the fortunes of many small towns and cities and contributed to the hollowing out of urban areas such as New Orleans, St. Louis, and others. This loss of commerce is analogous to the loss of nutrient flows to an island due to shifting currents and is another form of *Homo sapiens* habitat degradation.

Economic clusters are groups of interconnected firms, suppliers, related industries, and specialized institutions that develop around specific locations (Porter, 1998). The automotive and steel industries of the American Midwest are one example of an economic cluster, and the textile mills of the American South are another. In the Information Age, communities which are not proximate to important industry clusters, such as Silicon Valley in California, or lag in terms of bandwidth and technological infrastructure, find difficulty competing in the national or global marketplace. Massive investment in training, plant, and equipment in one industry can make it difficult for a



community to refocus its economy toward new opportunities as market conditions change. From this perspective, information flows are an important nutrient to urban health; and the absence of information flows is a form of *Homo sapiens* habitat degradation.

As economic opportunities are reduced for younger citizens, “bright flight” can result as the young and educated classes of a community seek opportunity elsewhere. This migration represents a negative flow of *Homo sapiens* intellectual and social capital, an essential urban nutrient. Demographic forces can in turn leave an aging community that is dependent upon services but no longer engaged in the work force. In the United States, there has been a mass migration to the warmer climates of the Sunbelt in the years since World War II (Phillips, 1969), accelerating the decline of many cities in colder climes.

Finally, some cities have prospered, and others failed due to civic leadership and the presence of a healthy business climate. Some, such as Detroit and New Orleans, have been challenged by crime and corruption (Allen, 2016. Baldas, 2013, and Kushner, 2010). Of the six most corrupt cities in the United States (Chicago, Detroit, Las Vegas, New Orleans, Newark, and Philadelphia), only Las Vegas is gaining population (Jenkins, 2011).

Geo-political forces, including war, can also lead to the decline of cities. The collapse of the Soviet Union, for example, contributed to the failure of many state-owned businesses that could no longer compete in the absence of a command economy. The collapse of the slavery economic in the United States following the American Civil War, no doubt shaped the futures of New Orleans and St. Louis. Shifting economic fortunes can be influenced by governmental investment policies and decision making as well.

Demographics can also play an important role in population decline. For example, since the mid-1970s, the fertility rate of the population of Belgrade has declined. This factor, coupled with a rising mortality rate since 1990 has led to an

overall decline in population. In this regard, the field of population ecology can also contribute to our understanding of shrinking cities.

### **3.1.1 Meta-population Theory and Hollowing Out**

Landscape ecology is the science of studying and improving the relationship between spatial scale and ecological processes (including socioeconomic processes) on multiple scales. Landscape ecology has long considered *Homo sapiens* and their activities as part of the landscape, its most salient feature that distinguishes itself from other ecological fields (e.g., population, community, and ecosystem ecology) is its explicit emphasis on spatial heterogeneity or pattern (Wu, 2013).

Just as ecologists describe a nested hierarchy of ecological units, socio-biologists have a similar hierarchy to define social units. A community is defined as an interacting population of various kinds of individuals (as species) in a common location. In an ecological sense this includes not only *Homo sapiens* but other plant and animal species found in a common location. Although the community of species in the urban biome is extensive, this thesis only focuses on *Homo sapiens*.

A population is all the individuals of the same species within an ecological community. Population ecologists are interested in the growth of a population, fluctuations in population size, the spread of the population, and any other interactions with the population or between it and other populations. The population abundance is the absolute number of individuals that compose this population, whereas population density is the number of individuals of a population in each unit area.

A society is a cooperating group of conspecific organisms. An aggregation is a group of individuals of the same species, comprised of more than just a mated pair or a family, gathered in the same place but not internally organized or engaged in cooperative behavior. A colony in strict biological usage, is a society of organisms which are highly integrated, either by physical union of the bodies or by division into

specialized zooids or castes or both. An individual is any physically distinct organism. A group is a set of organisms belonging to the same species that remain together for any period of time while interacting with one another to a much greater degree than with other conspecific organisms. The word group is used with the greatest flexibility to designate any aggregation or kind of society or subset of society. (Wilson, 1975). This thesis focuses on the species *Homo sapiens* within the urban ecosystem but does not consider effects on individual organisms and their habitat in New Orleans and St. Louis.

Population abundance and density rarely remain constant. Environmental conditions, interactions between individuals, interactions with other species, and the behavior and physiology of individuals can all influence the processes, and these factors drive population dynamics.

Cultural patterns, such as the clustering of *Homo sapiens* populations into groups based upon religious, ethnicity, sexual orientation or other affinity factors, as well as the impacts of racism, further divide the landscapes into patches. In this regard, meta-population theory (Levin, 1960) offers a perspective on the role of population dynamics in shaping *Homo sapiens* habitat (Morris and Mukherjee, 2006). A meta-population is a group of populations or group of groups of one species separated by space. These partially separated populations interact as individual members move from one population to another. Meta-population theory states that a large population consisting of a single species is most stable over a large area when divided up into smaller groups. These groups take advantage of small, local environments, or patches.

Viewed in this light, *Homo sapiens* disperse across the landscape seeking to occupy habitats that are suitable for their well-being. Such movement occurred before European settlement of North America. In the 1600s when Europeans first encountered native American tribes (a form of social group) in Illinois and Missouri, the Illini (a confederation of 10-12 tribes), the Quapaw, and the Chickasaw tribes occupied the area surrounding what is now St. Louis. These tribes and others fought with each other over territory resulting in shifting boundaries or patches of tribal lands over time. Treaties in 1808 and 1820 resulted in relocations. Members of these tribes remained in

the region until the Indian Removal Act of 1830 forcibly removed the remainder from these lands.

At a global, continental, or regional scale, the movement of *Homo sapiens* population between alternative cities, or at an urban scale within a city, is a demonstration of meta- population theory as individuals seek more suitable habitat. In a study of the migration patterns of Canadian *Homo sapiens*, for example, Canadians were found to disperse between cities in a way that maximized median household income (Morris and Mukherjee, 2006). This study found that *Homo sapiens* select habitat corresponding to that of a typical meta-population. Morris and Mukherjee also concluded in the same study that income represents a reasonable surrogate for *Homo sapiens* fitness and that median household income and employment rates were reasonable indicators.

As suggested by meta-population theory, the general mobility of modern populations is another contributing factor to population decline. Many shrinking cities, such as St. Louis, have lost population in the older, inner districts of the metropolitan area as residents have abandoned the heart of the city for the suburbs, a phenomenon referred to as “hollowing out.” In such situations, the total metropolitan population may be largely constant or even growing while the inner- city declines. Therein lies a definitional problem in the study of shrinking cities. Should one consider the legal boundaries of the city in question or the larger metropolitan area? The latter may often be comprised of numerous legal entities, some growing while others lose population. The greater St. Louis region, for example, contains 91 separate municipalities! A study of land vacancy on a regional basis would require assembling base data, including land vacancy information for all 91 municipalities. Ideally, an entire ecoregion defined by logical geophysical boundaries or habitat types could be examined comprehensively.

Researchers have put forth many arguments for this hollowing out of contemporary cities, including widespread use of the automobile, tax policies, anti-urban attitudes, and racism. While no one explanation is sufficient, in the case of New Orleans and St. Louis, racial issues, and particularly their impact on public school systems, clearly affected population dynamics. In the landmark *Brown v. Board of Education* ruling (1954), the United States Supreme Court struck down school

desegregation in United States, and the hollowing out of New Orleans and St. Louis began shortly thereafter. This “disturbance” resulted in population shifts between patches of the urban habitat as white populations left the inner city for the suburbs. There were other factors at work here: the post-World War II economic boom among middle classes, an increased emphasis on ‘new’ vs ‘old’, the popularity of the ‘suburban ideal’ of living, etc. In New Orleans, for instance, the destruction of older neighborhoods by Hurricane Betsy (1965) led many to abandon them in favor of newly developed suburbs. Though not all these neighborhoods are subject to flooding, residents also abandoned the city to escape the perceived threats of racial integration.

In the United States, other causes of this hollowing out include single use zoning and the mortgage interest deduction on the federal income tax. Where 150,000 people per square mile was once a standard urban density, it is rare to find densities of even 25,000 people per square mile in affluent cities today, and most urban dwellers live in densities much lower still (Bruegmann, 2005). At their peaks of population, the density of New Orleans and St. Louis were 3,704 people per square mile and 13,839 people per square mile respectively.

Further shifts in population within the New Orleans and St. Louis regions were a product of epidemics and disease, as residents sought healthier habitats. The miasma theory held that diseases were caused by the presence in the air of a miasma, a poisonous vapor in which were suspended particles of decaying matter that was characterized by its foul smell. The name of the killer disease malaria, from the Italian mala “bad” and aria “air” has its origins in this theory. The miasma theory was eventually replaced by the germ theory in the late 1800s, but the physical form of both New Orleans and St. Louis were shaped by this theory.

The Great Fire of 1788 destroyed every major building in the city of New Orleans (Figure 7). With a strong wind from the southeast, almost the entire city was destroyed. After six years of rebuilding, New Orleans experienced another significant fire in 1794 destroyed 212 buildings (Figure 8). As result of these fires, colonial officials required the construction of new buildings to be of masonry. The Great Fire of St. Louis in 1849 destroyed 430 buildings and led to the requirements that new



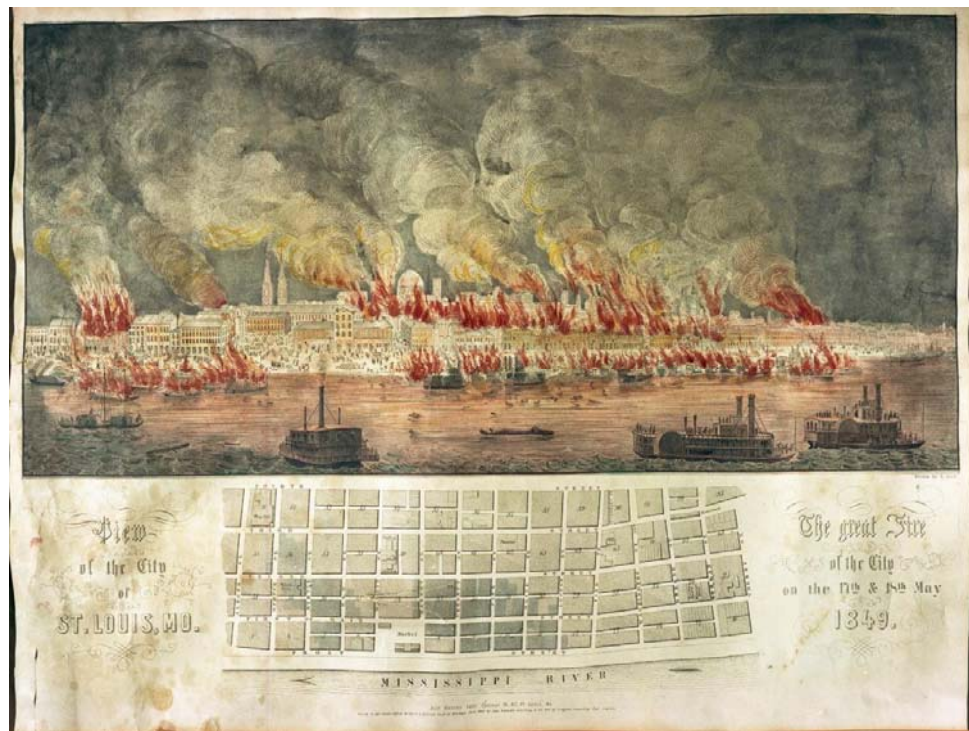


Figure 8: Lithograph of the Great Fire in St. Louis

Despite the obvious problems, several factors made high densities in cities necessary. One was the fact that most cities owed their existence to some specific geographical feature: in the cases of New Orleans and St. Louis, it is the Mississippi River. The cities that developed around these strategic points could not spread very far because of the limits of accessibility. Disruptive technologies and infrastructure such as rail, automobile, air transportation, and the Internet have loosened the bonds of urban concentration. Disruptive technologies in an environmental sense can be thought of as a form of disturbance. At the same time the flow of ideas and social interaction provide a countervailing force to this outward movement.

In New Orleans and St. Louis, as in other American cities, there were two kinds of suburban development. The first involved outward expansion all along the urban edge, creating a pattern of yearly growth like the annual rings on a tree. Despite the small number of inhabitants, the suburban districts for the affluent took

up a great deal of this space. Accommodations for the working classes and factories for industrial production were usually located on the other side of town and occupied much less space per capita than housing in the inner city. Beyond the colonial boundaries of the Vieux Carré of New Orleans, several faubourgs (residential suburbs) were created (Figure 9). As New Orleans expanded with economic prosperity and population growth, these neighborhoods were eventually absorbed within the fabric of the city.

In the case of St. Louis, the Central West End provided homes for the wealthy. The poor occupied the center city or lived even further east in East St. Louis. The other kind of suburban development appeared along railroad lines radiating outward from the city, creating streetcar suburbs like Clayton and Kirkwood, Missouri.



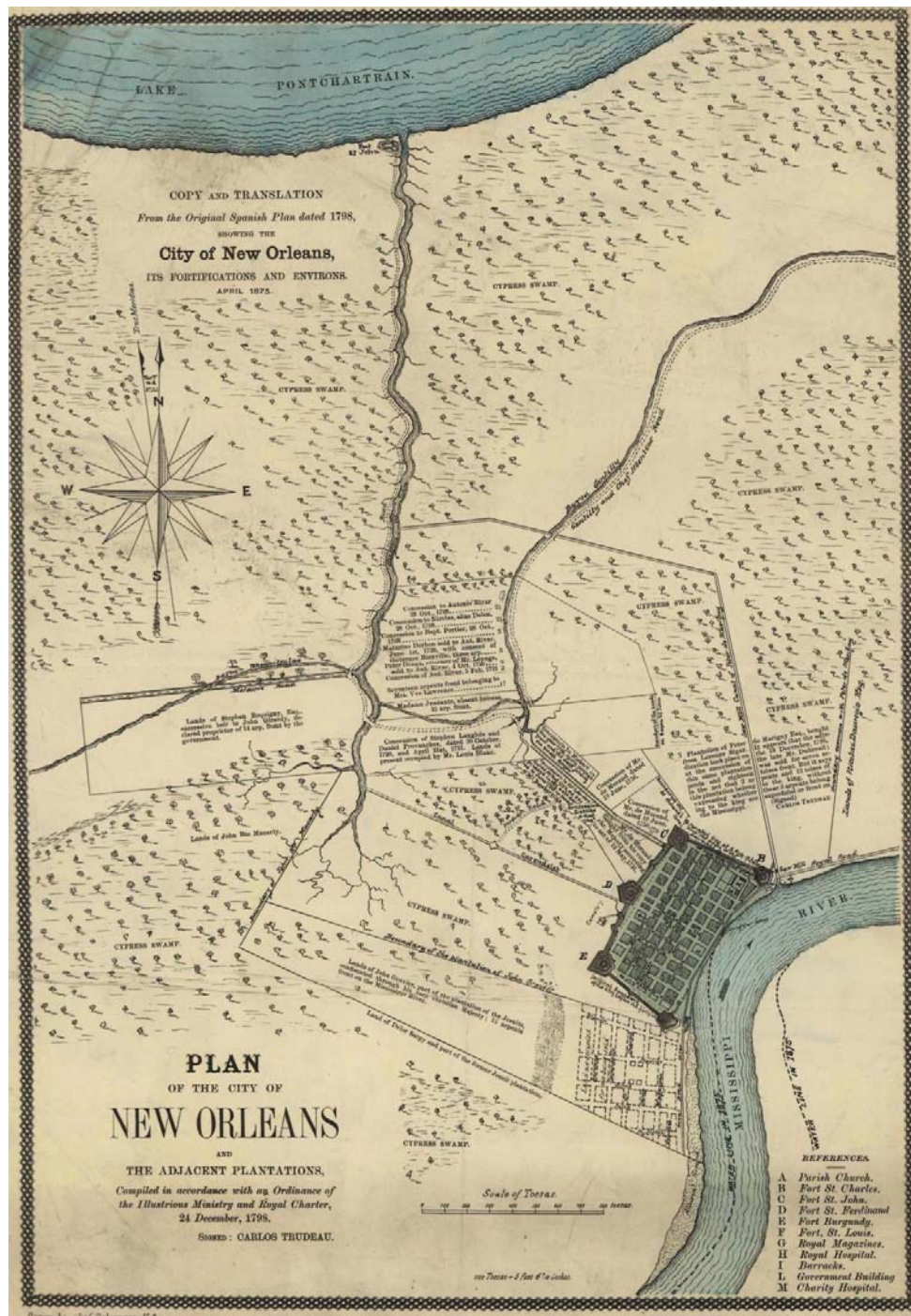


Figure 9: 1798 Map of New Orleans

One of the factors that made suburbanization possible was a notable expansion of infrastructure. In St. Louis, the construction of the great Kingshighway Boulevard in the 1920s was but one example of infrastructure improvements that facilitated suburbanization. These decades also were a period of remarkable expansion of the highway system in many cities, including the removal of dangerous railroad grade crossings, and planning for the Interstate highway system. The Federal Aid Highway Act was passed by Congress in 1954. The section of Interstate 70 in Missouri which is claimed to be the first component of the national system was built in the late 1950s, and rapid suburbanization of western St. Louis County and beyond followed. The construction of the Lake Pontchartrain Causeway, the world's longest bridge, which opened on August 20, 1956, facilitated the mass relocation of population from New Orleans to the North Shore of the lake. Construction of the Interstate highway system in Louisiana began in 1957, including the construction of Interstate 12 north of Lake Pontchartrain which allowed traffic to bypass New Orleans. This new route greatly facilitated the growth of communities in this rural area through the out-migration of population from New Orleans.

### **3.1.2 Implication of Time-Scale**

Will a city ever re-gain its original size once it has undergone a period of decline? Essential to answering this question is a determination of the time frame for evaluation. Several researchers including Schilling and Logan (2008) and Weaver (2017) have defined shrinkage as a 25 percent or greater loss in a city's total population over the course of four decades. In *Homo sapiens* populations, the generation time typically ranges from 22 to 32 years (an average of 27). By studying the entire period of *Homo sapiens* settlement in New Orleans and St. Louis, this thesis considers eleven and nine generations respectively, a far longer time frame that is typically applied to design interventions.

It will be foolhardy to begin a path of abandonment, demolition, and disinvestment only to see population return to the city shortly thereafter. At some point,

however, a city's declining economic health will mean that civic leaders can no longer maintain its extensive infrastructure or provide urban services to a far-flung and scattered population. A tipping point is inevitably reached in this evolutionary trajectory at which time a new direction is required. When this happens (or should happen), however, is unclear. A tipping point may be likened to the threshold effect which occurs when a species, population or meta-population experiences a dramatic change in population density or numbers due to change in a parameter such as habitat loss.

Interventions must be appropriate and well-considered, as one cannot be certain of the outcome of a city's evolutionary trajectory when viewed during the lifespan of a single designer, or a relatively brief span of time. Are today's shrinking cities tomorrow's vanished cities or will changing conditions lead to renewal? It is not certain that a city, once established, will continue to grow and prosper, or even to continue to exist. One might ponder what will become of today's great oil cities, such as Houston or Dubai, in a post-carbon world, or what might happen to a post-digital San Francisco.

Change in the landscape occurs over different time scales. Forman has suggested that a variety of time scales are at work in the ecology of a city (Forman 2014). As in the case of Hurricane Katrina (2005), a time-scale of minutes and hours can have a profound impact on a city's future. Daily changes in CO<sub>2</sub> conditions or plant evapotranspiration are also at work. The uncertainty of time-scale suggests the need for a management strategy that is flexible and resilient.

Multi-year changes seem especially widespread in urban areas. Termites and weather degrade wooden structures, species populations change (one species is supplanted by another), and vacant lots appear and disappear. Multi-decade changes describe the obsolescence of the St. Louis combined sewer system or the creation of economic decline in the American Midwest and in turn, the shrinking of many cities in the region due to the global restructuring of the automobile industry. Over-centuries time-scale has been useful in understanding changes wrought by changes in transportation systems, as cities have moved from rail to the automobile and now to the

aviation age. The advent of autonomous vehicles will create further changes in urban form. That change occurs over multiple time scales, further complicating analysis. Slavery existed in the United States for 245 years; the Emancipation Proclamation was signed in 1865; and the Fair Housing Act was passed in 1968. Each change in social policy has resulted in changes in urban form. One might hypothesize that patches created due to social policies may be even more persistent than those wrought by technological change in some cases.

Devising experiments to test the benefits of alternative interventions are, in turn, very difficult, and evidence of the benefits or failures of a design intervention may not be visible within the lifetime of a single designer or researcher, due in large measure to the fact that one cannot predict future events that will influence one's proposed design strategies and interventions. More importantly, the time scale over which design interventions endure (or have influence) make it challenging to assess the effectiveness of interventions. Design interventions often effect places for decades if not centuries, and affect multiple generations. Some of the population may move in and out of a location during their lifetime, while others may be born and remain their entire lives, while others move to new locations never to return. Changes to a population over time thus create challenges in assessing design interventions to the built environment at a population level.

Time-scale is also a consideration in ecological conditions. It is estimated that the Mississippi River was formed 10,000 years ago, at the end of the last Ice Age. The Paleozoic geological formations which underlies St. Louis are 250- 550 million years old. The impact of these environmental factors is very persistent. The current urban forest of St. Louis that replaced the pre-settlement prairie landscape of the region has evolved through environmental succession over the last 250 years, though few trees of the current canopy are likely more than 100 years old. The impact of vegetation, while important to the health of the urban ecosystem, is less persistent in its effects on the city.

Reconstructing the environmental history of an urban landscape provides a window into the interaction of natural and social processes through time. This kind of history can be gleaned from historical documents (especially maps and photographs), written accounts, verbal descriptions, and landscapes themselves. Studying environmental change over time shows that urban landscapes are dynamic, how natural processes are significant agents in urban development, and how social and cultural processes are active ingredients of urban ecosystems. (Spirn, 2003). The environmental history of a place provides a window into the ways natural and social processes interact through time, and how planners have intervened, for good or bad effect (Cronon, 1991, White 1996, Klinge, 2007).

Preservation, conservation, restoration, reconstruction, and renewal are distinct approaches to managing an ecosystem. Preservation and conservation are most appropriate when the ecosystem is vital and intact, and the task is to manage it. In the preservation theory, the goal is to retain a landscape in its current state and protect it from *Homo sapiens* use; in the conservation approach, the goal is to manage the ecosystem for “wise use” by *Homo sapiens*. The goal of restoration is to reconstruct or repair a damaged ecosystem to return it to a former, healthy condition. In this regard, a shrinking city is a damaged ecosystem in need of restoration. The purpose of renewal, unlike the other three approaches, is to improve the condition of an ecosystem through the introduction of a wholly new element such as a neighborhood or park.

Desjardins has argued that an understanding of history does not suggest returning an ecological system to its original state (Desjardins, 2014). The Society of Ecological Restoration International defines ecological restoration as “the process of initiating or accelerating the recovery of an ecosystem with respect to its health...[it]attempts to return an ecosystem to its historic trajectory.” Historical conditions are therefore the ideal starting point for restoration design. Such an approach assumes the existence of a balance of nature – the belief that if left alone an ecosystem in each physical environment will progress toward a (predictable) stable equilibrium state. Desjardins argues that the balance of nature approach to ecological restoration is based on a successional-based model. Successional-based restoration attempts to re-

establish historical abiotic conditions (particularly disturbance regimes) to promote the natural return of a (pristine) non-degraded ecosystem.

### **3.1.3 Path Dependency Theory**

Instead Desjardins suggests a path-dependent model of ecological restoration. He suggests that path dependence is a property of stochastic processes. Stochastic processes are randomly determined; having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely. Since the 1970s, biologists have increasingly recognized the relevance of “historical contingencies” in explaining the dynamics and distribution of biota on earth. This “historical turn” has taken different meanings, many of which can be interpreted in terms of path dependence and is opposed to the balance of nature ideal.

Studying the distribution of species for example, several biologists came to realize that chance in the form of random historical events might play a large role in building up non-identical communities that represent alternative stable equilibria. This is also known as the priority effect. The first species to arrive in a habitat change the resources available and make the habitat either suitable or marginal to other species. Consistent with the priority effect, the entrance of *Homo sapiens* into an environment creates marginal habitat for many other species. In the long run, the notion of path dependence can also explain why restoration efforts sometimes fail. The existence of positive feedback between biotic and abiotic processes can increase the resistance of system in degraded state (lock-in phenomena). Past a certain threshold, the degraded site becomes resistant to restorative efforts. Resilience is a measure of how much disturbance can be tolerated with full recovery being possible. Loss of resilience is a form of degradation. Resistance is a measure of how much disturbance can be tolerated before a marked change in the system occurs (Nicholson, 2011). The same restoration actions will possibly yield different outcomes, depending on the history of a site. If Desjardins is correct, this lock-in phenomenon may explain why portions of the urban

environment, particularly persistent pockets of poverty, is resistant to restorative efforts.

In adopting a path-dependent model of nature, Desjardins invites several changes to ecological restoration theory: first, taking the “priority effect” seriously, he suggests that ecologists should expect that community composition, structure, and function may not return to some historical “reference level.” Returning to historical conditions can be very unlikely when the “initial” state is different. Desjardins hypothesizes that the goals of ecological restoration should not be “historical” but “futuristic.” He suggests the setting of dynamic goals (instead of seeking seemingly static past environments and ecosystems) based on the knowledge of multiple possible trajectories. Second, Desjardin suggests that ecologists should expect multiple possible outcomes from a given initial state and recognize that the same action can have different impacts on the same ecosystem depending on the site’s history and its degree of degradation. Third, a new methodology is needed if the successional-based model cannot universally apply. The alternative equilibria model, which is gaining in popularity in restoration ecology, naturally embraces “path dependence.” This model assumes that the dynamics of degraded systems are different from pristine conditions and that the trajectory to recovery will be different from that of degradation. Fourth, a path-dependent view of nature recognizes that chance events, management disturbances, and resources exploitation can shape the system’s structure and cause it to “flip” into new local equilibria. Desjardin argues that this view favors “futuristic” dynamic goals and alternative state models. Fifth, the success of restoration actions depends on our capacity to identify and act on feedback interactions leading to resilient degraded states. Several constraints can shape these processes (physical, biological, and socio-economical). Thus, there are different levers to manipulate, perhaps at different times. Echoing Lyle, Desjardins suggests that this expertise could develop through “adaptive management” (which takes policies as hypotheses and management actions as test) and “scenario planning” (i.e., by a comparative analysis of possible scenarios guiding the choice of policies). Finally, adopting futuristic goals raise an important question about the identity and value of ecological restoration.

To chart a new path for the future of a city, as with other habitats, one must first understand the path the city has followed to arrive at its current condition. Change is often difficult because a community has become dependent upon established paths, based upon past decisions or events. Such past decisions may include the location choice of the city or decisions to build in environmentally sensitive areas such as floodplains or steep slopes. In New Orleans, such decisions may include economic factors based on slavery as an economic system. In the case of St. Louis, a defining path may be the Missouri legislature's decision in 1876 to limit the growth of the city to specific boundaries. Path dependency theory was originally developed by economists to explain technology adoption processes and industry evolution, but this theory has relevance to ecologies of the built environment as well. The evolutionary approach to economics hypothesizes that economies change in path-dependent ways, shaped and constrained by past decisions, chance events and accidents of history (Redding, 2002).

The recognition that a city's condition is constantly in flux, suggests that an appropriate design outcome is not one that seeks to achieve an optimum or preferred urban form but one that is flexible and resilient and thus able to accommodate a variety of equilibria over time. Ecologists now speak of punctuated equilibrium, the idea that ecosystems achieve stasis for only moments in time before returning to dynamism. Cities may be thought of in much the same way. New Orleans and St. Louis likely reached punctuated equilibrium for a short period in the late 1960s when they ceased to grow in population and just before population decline began.

Urban planners and designers throughout history, from Ildefonso Cerda (Souza y Cerda, 1999) to Andres Duany (Duany, 2003) have often defined an optimum theory of urban form. Many envision an optimum static form and accompanying codes to insure the form is maintained. The urban-rural transect of New Urbanism and accompanying form-based codes are such an example. Few theories of urban design account for the continual evolution and re-structuring of an ecological city (Figure 9).



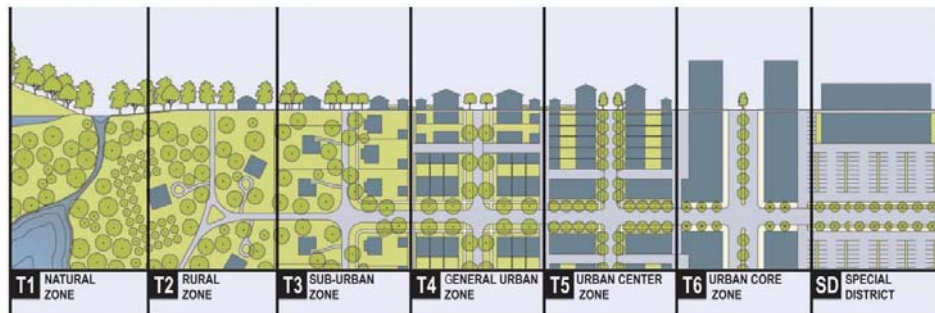


Figure 10: Urban Rural Transect

With path dependence, both the starting point and “accidental” events (disturbances) can have significant effects on the ultimate outcome, as New Orleans found with Hurricane Katrina. Similarly, the decision to manage flood risk in the city through an extensive system of extensive sub-surface infrastructure, levees, canals, and massive pumping systems represents another form of path dependency for the residents of that city. Path dependencies can be based upon physical or economic decisions but also upon institutional frameworks. The current institutional framework of the New Orleans Sewerage and Water Board, the Orleans Levee District, and the United States Army Corps of Engineers all managing the lower Mississippi River valley is yet another facet of the city’s current path dependency.

The policies of all three institutions have been oriented on keeping water out of the city by any means necessary. The Mississippi River in St. Louis is similarly managed by the Corps of Engineers and several levee districts. Recent efforts in New Orleans are seeking to modify this path dependency by exploring ways that residents can allow water into the city while still protecting the city ([livingwithwater.com](http://livingwithwater.com), 2016).

Similarly, two early sets of decisions in St. Louis continue to shape that city. One involved zoning and deed restrictions to force African-American residents into sections of the city. These decisions had the impact of confining or directing these residents into certain areas of the city and concentrating poverty. The other set of

decisions involved Missouri's policies regarding the incorporation of new municipalities and the collection and distribution of sales tax. In 1969, the Missouri Legislature empowered municipalities to levy a one cent sales tax. Thus, some communities generated higher sales tax revenues than others, creating enormous inequities across the region. This differential in sales tax creation encouraged the creation of wealthy enclaves where residents did not have to share their tax revenue with their poorer neighbors in the region. As wealthier residents fled the city and sought these enclaves on its perimeter, the City of St. Louis dramatically lost income.

The construction of levees along the Mississippi River (particularly along the edge of the American Bottom in Illinois) created a path dependency and dramatically altered the habitat conditions of that landscape, and the great galleries of cottonwoods and other riparian vegetative species that once covered this landscape are now gone. Levees are an example of a management solution that seeks to suppress natural processes and "fix" habitat patches in place.

In fairness to the founders of New Orleans and St. Louis, their goals were to carve *Homo sapiens* habitat out of what was, for them, a wilderness. The founders of both cities no doubt made the best decisions possible with the information at hand. Their decisions about the management of drainage in New Orleans or a combined sewer system in St. Louis are third-degree path dependencies.

Williamson (1993) introduces the term "remediability" to refer to the circumstance in which known feasible and preferable alternatives exist. To suggest strategies to solve the problems of shrinking cities and to move from existing path dependencies requires confidence among decision-makers that the situation can be remedied. Remediability also presents the challenge of defining the problem to be solved or cured. The wicked nature of urban problems is that multiple path dependencies are at work simultaneously – prior economic, ecological, social, and management decisions combine in different ways over different time scales to define a city's current condition and its future. The concept of remediability implies that a problem can be fixed. For example, following a major disturbance event like Hurricane Katrina, a theory of remediability would suggest that development in flood-prone areas

of New Orleans can be made less flood prone. Alternatively, resilience is the ability to prepare and plan for, absorb, respond to, and recover from adverse events. The acknowledgement of these adverse events is in keeping with the concept of dynamic patches of habitat. Over time, New Orleans can be made more resilient through returning vacant areas below sea level to open lands and through the implementation of a blue ways system. Similarly, the combined sewer system of St. Louis can be remedied through the construction of separate sanitary and storm systems, the latter with great emphasis on green infrastructure.

One key tenet of path dependency theory is the concept of the "critical juncture," in which conditions allow contingent choices that set a specific trajectory of development and consolidation that is difficult to reverse. The components of this concept are lock-in, positive feedback, increasing returns (the more a choice is made the bigger its benefits), and self-reinforcement (which creates forces sustaining the decision). In the case of New Orleans, two critical junctures in the city's history may be identified. One occurred in 1893, with the founding of the Sewerage and Water Board with subsequent decisions to build the major canal and pumping system and to expand the levees as a means of flood management. The second critical juncture occurred in 2005 with the failure of that system during Hurricane Katrina and a resulting search by the community design leaders for alternatives to the flood protection systems of the past.

Similarly, for St. Louis, the consent decree of 2007 requiring the community to address its combined sewer issues at the projected cost of \$4.7 billion of the next twenty-three years represents a critical juncture in the city's history. St. Louis appears to be gradually pursuing solutions to its combined sewer system that emphasize green infrastructure solutions, thereby reducing dependence on storm water piping and pumping. The impact of path dependencies suggest that in order to understand the causes of publicly owned land vacancy, one must understand the environmental history of the city.

## **3.2 THE CHALLENGE OF VACANT LAND**

### **3.2.1 The Definition of Vacant Land**

Establishing a framework for vacant land policy requires a clear definition of vacant land. Lynch defined open space as: an outdoor area in the metropolitan region which is open to the freely chosen and spontaneous activity, movement, or visual exploration of a significant number of city people. Open space is the negative, extensive, loose, uncommitted complement to the system of committed land uses that make up a city region (Lynch, 1965). Vacant land in this sense is not open space though it may be put to such use.

The legal and insurance industries in the United States have developed definitions of vacant land. A legal definition is “land not being used at the present time but that may have utilities and infrastructure in place, in contrast with raw land.” (Evans and Evans, 2007). The Insurance Services Office defines vacant land as “any land on which there exists no man-made structures.” (ISO, 2018).

As cities have lost populations, properties, including vacant lots and buildings, are often abandoned. Property owners fail to pay property taxes and the land is then claimed by the municipal government in lieu of taxes. Therefore, vacant land can be in both private or public ownership. This research focuses on the latter.

### **3.2.2 Types of Vacant Land**

The term vacant land is broad and imprecise (Bowman, Pagano, 2004). Vacant land is an elastic concept. All cities have vacant land, though the supply, kind, and conditions vary. On average, less than one-sixth (15.4 percent) of a city’s land is vacant. Cities that lost populations (between 1980 and 1995) averaged less than half the vacant land within their borders as the average in a survey by Bowman and Pagano (6.04 to 15.4 percent).

Fixed boundary or inelastic cities such as New Orleans and St. Louis reported negligible change in vacant land from 1980 to 1995, less than the average of all cities studied and substantially less than expanding cities (8.8 versus 23.3 percent) which were bringing large tracts of land within their boundary via annexation. In New Orleans, however, there were 16,955 publicly owned vacant land parcels in 2012, or 11 percent of total land parcels in the city. In St. Louis, there were 17,955 publicly owned vacant land parcels in 2012, or 20 percent of the total land parcels in the city. This research does not consider publicly owned land that is managed or developed for other purposes, such as parks, nor did this study examine privately-owned vacant land parcels.

The Bowman and Pagano survey (2004) suggests that almost three-quarters of a city's vacant land is private and one-quarter is publicly owned. This suggests that the total amount of vacant land in New Orleans and St. Louis may be four times that of publicly owned land acreage.

Bowman and Pagano's survey suggests that these imperatives predominate publicly owned vacant land policy in American cities: 1) the need to enhance the fiscal condition of the city; 2) the need to minimize social disruption and protect property values in the city; and 3) the need to augment or, at a minimum, maintain the economic vitality of the community and to sustain and enhance its image (Bowman, Pagano, 2004). It is for these reasons that the City of New Orleans auctioned 3,000 parcels of publicly owned vacant land in March, 2015. Apparently, no consideration was given to whether the development of these properties would place residents back in harm's way due to flooding and other natural threats (McLendon, 2015).

The fiscal imperative is greatly influenced by a city's "land-tax dynamic." Municipal governments are engaged in a competition that induces a spatial revenue-maximization strategy. The choice of encouraging or facilitating development of publically-owned vacant land at one site or another depends in large part on the general taxing authority of the municipality. Different tax structures produce different land use choices. This is a challenge in the St. Louis region with its 91 municipalities, some of which derive their major tax revenues through "point-of-sale" sales tax

regimes, while others participate in a county-wide pool. The patch dynamics and land mosaic of St. Louis are heavily influenced by these tax policies. St. Louis is one of the few cities in the United States with all three forms of general taxation (income, property, and sales).

Civic leaders in cities dependent on property tax think strategically about the pattern of vacant land use based on the market value of the development and on the possibility of shifting service-delivery costs to other jurisdictions (fiscal externalities). Officials in cities that are dependent on sales taxes think strategically about the temporal development of vacant land based on their mental constructs of “shopping sheds” and on which transactions are taxable. Those in cities dependent on income taxes think strategically about vacant land uses based on their assessment of the income growth potential of the individual or firm. Knowing a city’s revenue structure, then, should allow one to predict which publicly owned vacant land parcels ought to be developed for maximizing revenues or minimizing costs, thereby facilitating the city’s goal of enhancing the health and well-being of its residents. In the absence of strong market demand, conversion of these vacant lands is almost impossible without significant government intervention and investment.

Nearly 55 percent of large cities lack the legal authority to seize adjudicated property. While both New Orleans and St. Louis have this capability, land typically goes to tax sale once reclaimed by the city due to failure to pay taxes. The property owner who has lost their property due to a failure to pay taxes has an eighteen-month redemption period during which they can reclaim the property by simply paying outstanding taxes with interests. Therefore, one might conclude that it is only vacant properties with limited market value that make their way to the New Orleans Development Authority or Land Redevelopment Authority in St. Louis. Properties with perceived market potential are often purchased by new buyers at tax sale.

Vacant land contextualizes settlement structures in many cities by delineating neighborhood and micro-communities or groups. Whether segregated housing and neighborhoods reflect purposive race consciousness or whether segregation is a by-product of individuals maximizing their own welfare, recent census tract data

demonstrates that individuals with similar income, race, ethnicity, and education continue to cluster in neighborhoods or micro-communities within cities. City officials are thus put in positions of regulating land use to ensure property values and by so doing (inadvertently or intentionally), their actions reinforce the racial, income, class, or ethnic homogeneity of those micro-communities (Bowman and Pagano).

### **3.2.3 Current Methods to Address Vacancy**

The primary method utilized by most cities to address land vacancy is to sell publicly owned vacant land in hopes that they will be redeveloped by the private sector. In Bowman and Pagano's survey (Bowman and Pagano, 2004), two-thirds of the 99 American cities surveyed acquired vacant land and sold it to developers. About one-third assembled and consolidated land parcels. Approximately 61 percent clear land in anticipation of redevelopment. Roughly one-third of the cities surveyed sold land at discounted prices to developers to induce development.

Poorly maintained vacant land created through abandonment threatens the value of nearby property. A contagion effect occurs, with a vacant lot in the middle of the block negatively affecting the value of adjacent parcels. An abandoned structure on a corner can also have an impact on the value of adjacent blocks. Economic development in the absence of a strong real estate markets is extremely difficult.

In some cities, demolition of entire public housing developments has been the preferred approach. To stop the steadily rising vacancy rates and, in turn, the increasing operating costs per housing units, officials have eliminated entire housing developments. In St. Louis, the demolition of the infamous Pruitt-Igoe housing project [1972] is one example of transformation by demolition. In New Orleans, the Lafitte and Iberville public housing developments have also been demolished [post-Katrina], although they have been replaced with new public housing developments designed to integrate housing structures more gracefully into the city by reflecting the scale and character of the surrounding neighborhoods. Time will tell if redeveloped Lafitte and

Iberville housing developments develop the stigma of their predecessors which, although well-constructed, and well detailed, became known as “projects” because there were ten such developments throughout the city and were constantly sites of crime. The development of public housing or other projects deemed incompatible with surrounding neighborhoods could be considered a form of disturbance.

Under this scenario, the belief is that by reducing the oversupply of housing, thereby underwriting the rents and sales prices of the remaining housing, the housing market is supported. The residents are relocated, thus increasing the occupancy of the remaining housing blocks and the efficiency of public service and rebuilding the social fabric of the remaining neighborhoods. Building demolition, however, results in the creation of new publicly owned vacant lands which in turn require their own solution.

Land banks have emerged as one tool in the transformation process. Land banks are mechanism by which the government acquires vacant or abandoned properties and reassembles these land holdings for redevelopment. New Orleans has created a land bank, the New Orleans Redevelopment Authority. St. Louis’ land bank is known as the Land Reutilization Authority. Land banks are transaction in nature with a mandate to return vacant lands to the tax roles, not on improving the social and economic condition of residents in areas impacted by publicly owned land vacancy. Urban land trusts are emerging as a technique to acquire publicly owned vacant lands and put them to a wider range of uses to benefit local communities.

An additional technique utilized by civic leaders and planners is sometimes referred to as blotting. Blotting occurs when a property owner acquires or annexes the property next door, creating an expanded lot. Both New Orleans and St. Louis have aggressive programs to sell vacant parcels to adjacent property owners. The Lot Next Door program of the New Orleans Redevelopment Authority and the similar efforts by the St. Louis Land Reutilization Authority are examples of blotting programs (Ganning, 2014). Under this scenario, property owners acquire, through gift, sale, or lease at low rates, the vacant properties adjacent to their homes if the person acquiring the property agrees to expand an existing residence or to provide landscaping or gardening. The effect of the strategy is to reduce vacancies. Formerly derelict lands are



improved and maintained by their new owners and tenants, improving the appearance and health of a neighborhood and reducing the cost of public service and maintenance. Critics, however, have argued that blotting amounts to the suburbanization of the city. The resulting urban densities are too low for the efficient provision of transit, education, and other public facilities and services.

An alternative to blotting is the process of re-greening. Under this approach, vacant or derelict lands are converted to farm or timber lands or returned to habitat. Presumably new economic opportunities are created through the development of agricultural and timber industries. The agricultural footprint of the population can be balanced by the surrounding landscape. The restoration of habitat can provide recreational opportunities for residents, as well as, opportunities for storm water management and air quality improvements.

### **3.3 *HOMO SAPIENS* IN NATURE**

To develop formalized processes for addressing publicly owned vacant lands, it is important to understand the factors which contribute to land vacancy. In this regard, it is useful to understand the city as *Homo sapiens* habitat.

Few writers have placed *Homo sapiens* clearly within the environment with most writers choosing to describe *Homo sapiens* as apart from the natural world (Cronan, 2005). Perhaps we chose to see *Homo sapiens* as apart from nature for religious reasons: “And God said, let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth.” (The Bible, King James version, Genesis 1:26). Perhaps we chose to see *Homo sapiens* as different from other living beings because, to our knowledge, *Homo sapiens* are the only sentient creatures, aware of their condition and capable of mindful actions to shape their own environment. One notable exception to the view of as apart from nature is zoologist Desmond Morris’ classic book, *The Naked Ape* and his

subsequent publication *The Human Zoo*, which considered place of man in the urban environment. Morris stated that “despite our grandiose ideas and our lofty self-conceits, we are still humble animals, subject to the basic laws of animal behavior.” (Morris, 1967).

From the perspective of this research, *Homo sapiens* are considered but one species within the ecosystem, albeit the only one with the known ability to shape its habitat through acts of design and management. Once one views *Homo sapiens* as but one species within the ecosystem, then many ecological theories, often applied to the habitat of other species, may be applied to *Homo sapiens* habitat as well.

In the eighteenth century, the Scottish School including Hume sought to correlate social organization with subsistence and sought to explain *Homo sapiens* society in terms of increased control over nature (Moran, 1979). Exploring the question of teleology in nature, Kant concluded that the landscape and living forms are the result of historical events, not of final causes.

Through the nineteenth century, most scholars viewed culture and history from the perspective of environmental determinism, the idea that the physical environment predisposes societies and states toward particular development trajectories. Ratzel, for example, emphasized the primacy of habitat in bringing about cultural diversity. He believed that *Homo sapiens* society reacted to nature like any animal to its habitat and explained cultural evolution as spurred by the conflicts over territory between migrating peoples (Moran, 1979). He argued that natural boundaries created by topography and location gave definition, distinction, coherence, and unity to political units and other cultural entities. Belief in environmental determinism continued into the twentieth century. Foretelling the work of urban political ecologists, Ratzel described the same contestation of landscapes found in urban habitats today as individuals and social groups compete for their space in the city.

The field of biology as a separate discipline did not emerge until the 19<sup>th</sup> century. Naturalists like Darwin, studied the relationship between environmental

change and modifications in biological forms. Malthus, and others developed theories of nature as a limited factor. Boas, believed that nature circumscribes the possibilities for *Homo sapiens*, but historical and cultural factors explain what possibilities are chosen. Boas, in an approach known as historical possibilism, believed that *Homo sapiens* use what they want in nature, and that it is cultural decisions not nature, that dictate the direction of cultural change. In Boas scheme, culture takes precedence over environmental settings. Goldenweiser suggested that *Homo sapiens* change the natural environment and as a result make their own environment instead of being determined by it (Moran, 1979). This view deemphasized the role of nature but raised awareness of culture in environmental adaptation.

All species must adapt to their environment to persist. E. O. Wilson wrote that manipulation of the physical environment is the ultimate adaptation. From a biological perspective, an adaptation is the ability of a species to survive in a particular ecological niche, especially because of alterations of form or behavior brought about through natural selection. Although other species of the genus *homo* have occupied the earth for 6,000,000 years, the species, *Homo sapiens* are known to have occupied the planet for only 200,000 years.

Civilization is a behavioral adaptation only 6,000 years old (Vermeij, 2010). Uruk, founded in Mesopotamia in 4500 B.C. is generally considered the oldest city in the world. One might theorize that cities will continue to evolve as an adaptation or be replaced by yet another adaptation. Shrinking cities may be unsuccessful adaptations (Mark, 2014).

Biologist Ernst Mayr stated that all biological processes have both a proximate cause and an ultimate cause. Proximate causes relate to the functions of an organism and its parts, as well as, its development. Ultimate causes explain why an organism is the way it is. No biological problem is fully solved until both the proximate and ultimate (evolutionary) causations have been elucidated. Every organism, whether an individual or a species, is the product of a long history. There are no absolute phenomena in biology. Everything is time- bound and space-bound (Mayr, 1982).

If adaptation were brought to perfection, environmental control would ensure the indefinite survival of the species, because the genetic structure could at last be matched precisely to the favorable conditions and freed from the capricious emergencies that endanger its survival. No species, including *Homo sapiens*, has approached full environmental control (Wilson, 1975). Over the course of each city's history, the residents of New Orleans and St. Louis adapted the environment to meet their needs. A longitudinal study of historical maps reveals the degree to which *Homo sapiens* re-shapes the environment. For example, in New Orleans, the filling of Lake Pontchartrain on its southern shore in the early 1930s created land for new residential development. In St. Louis, Duncan's Island was systematically removed to improve navigation in the Mississippi River. Bloody Island was joined to the Illinois shore.

In ecology, the term adaptation pertains to the adjustment or change in behavior, physiology, and structure of an organism to become more suited or fit to an environment. *Homo sapiens* adaptability emphasizes the plasticity of *Homo sapiens* response to the environment. This plasticity is manifested in both physiological and social/cultural terms. Physiological responses require changes in organic structure and function and thus take longer to come into operation than social/cultural responses. Both types provide a more rapid mechanism for improving survival chances than genetic change, which is accumulated over generations. Physiological and social/cultural responses imply that most adjustments are reversible and that *Homo sapiens* retain a great deal of flexibility in coping with changes in their habitat. (Moran, 1979).

British botanist Sir Arthur Tansley, who defined the ecosystem concept in 1935, argued that *Homo sapiens* activities were among the factors that determine ecosystem structure and function (Tansley 1935). He defined an ecosystem as an interacting assembly of living things and their non-living environment. Among living things are *Homo sapiens* and *Homo sapiens* usually choose to think of themselves as somehow set apart from ecosystems. All ecosystems are open systems in that they are

connected by flows of energy, materials, and information. Each system draws its energy and materials from the systems around it and, in turn, exports to them.

For purposes of observation, ecologists have defined a hierarchy of organization of the environment that classify environmental units by scale, both time and space. The units of the ecological system are typically ranked: biosphere, biome, landscape, ecosystem, community, population, organism, and cell. The biosphere is the regions of the surface, atmosphere, and hydrosphere of the earth occupied by living organisms. In this hierarchy, the urban environment is a biome: a distinct ecological community of plants and animals living together in a particular climate.

An urban biome is an area found in cities or towns constructed by *Homo sapiens*; it is also found in many diverse climates. These climates can range from the arctic to the desert and everything in between. *Homo sapiens* are the dominant species in the urban biome. (Pencetl, 2015). Nested below the hierarchy of biome is the concept of landscape.

In the 1950s, ecological approaches toward the adaptation of *Homo sapiens* to their environment became more prominent. Steward, in an approach known as cultural ecology, used a comparative approach applied to societies across time and space in search of valid generalizations about *Homo sapiens* behavior. Steward hypothesized that the immediate impact of environment on behavior decreased as technological complexity improved the *Homo sapiens* capacity to modify the environment. He suggested that in complex societies social factors may be more important in explaining change than technology or environment (Moran, 1979).

Steward expanded the scope of cultural ecology to include political, religious, military, and aesthetic features of culture. Edgerton, building upon Steward's work, suggested that culture is the result of situation-specific adjustments, reflecting the interaction of people adapting to environmental circumstances by technological means, at a given point in their history.

Other scholars applied a more biological approach to cultural ecology, an approach now known as ecological anthropology. The research strategy of ecological anthropology is to study a wide range of *Homo sapiens* responses to environmental problems, to social constraints, and to past solutions to environmental problems. Geertz was perhaps the first anthropologist to argue for the ecosystem as a viable unit of analysis for cultural anthropology. From his studies, Geertz concluded that techno-environmental features are not sufficient to explain the facts.

Rappaport and Vayda argue that the term cultural ecology obscures the applicability of principles of biological ecology to the study of *Homo sapiens* adaptation. They believe that anthropologists should not hesitate to adopt biological units as units of study. Bennett criticized Rappaport's approach for its use of biological analogies but conceded that his approach demonstrated that the behavior of *Homo sapiens* toward each other, as well as toward nature, is a part of ecosystems. Cultural anthropologists replaced culture and society with populations as the unit of study and measurement. Investigations include considerations of eco-systemic relationships, *Homo sapiens* physiological responses to environmental stresses, and social/cultural adjustments.

### **3.3.1 Insular Biogeography Theory**

Insular biogeography theory examines the factors that affect the species richness of isolated natural communities. The theory was originally developed as insular biogeography in the 1960s by ecologists Robert H. MacArthur and E.O. Wilson (MacArthur and Wilson, 2001) to explain species richness of islands, principally oceanic, but is now applied to any ecosystem (present or past) that is isolated due to being surrounded by unlike ecosystems. This theory has now been extended to mountain peaks, fragmented forests, oases, and natural habitats isolated by *Homo sapiens* land development. Insular biogeography theory has been applied in evolutionary ecology to study the evolution of the species *Homo sapiens* (for example, the habitat relationship of Neanderthals and Cro-Magnons to modern *Homo sapiens*

[nationalgeographic.com, 2015]), but a literature review failed to uncover examples of this theory to *Homo sapiens* habitats found in contemporary urban environments. Several researchers have commented on the relationship between isolation and the spatial vulnerability of disadvantaged *Homo sapiens* communities (Logan and Molotch, 1987), Marcuse, 1997), Freeman, 2006), Dyson, 2006), and Wacquant, (2008).

The theory of insular biogeography proposes that the number of species found in an undisturbed insular environment is determined by immigration and extinction. The isolated populations may follow different evolutionary routes. Immigration and emigration are affected by the distance of an island (or patch) from a source of colonists. This is known as the distance effect (MacArthur, Wilson, 1967). Islands that are more isolated are less likely to receive immigrants, whether *Homo sapiens* or of other species, than islands that are less isolated. From the perspective of island biogeographic theory, cities that are separated from sources of potential immigrants by disturbances such as changing transportation patterns or shifting industry clusters are less likely to receive immigrants. Biologist Stewart Pickett and others have increasingly sought to apply insular biogeography theory to the urban environment. The Baltimore School of urban ecology has evolved around Pickett and his colleagues with the Baltimore Ecosystem Study which began in 1997 (Grove, 2015). The Baltimore School suggests an approach to urban ecology that emphasizes patch dynamics.

The rate of extinction once a species manages to colonize an island is affected by island size. This is the species area curve or effect. Larger islands contain larger habitat areas and opportunities for more different varieties of habitat. Larger habitat size reduces the probability of extinction due to chance events including disturbances. Habitat heterogeneity increases the number of species that will be successful after immigration. In an urban application, one might hypothesize that as the economic diversity of urban environments decreases due to over dependency on one industry, as in the example of British mill towns, the suitability of the urban habitat is reduced.

*Homo sapiens* create “islands” by surrounding neighborhoods and isolating urban populations with railroads, major highways, industrial land uses, and a variety of

management decisions. Just as they fragment the habitat of other species, railroads, major highways, and incongruous land uses and management decisions fragment *Homo sapiens* habitat as well. The isolation of the St. Louis area communities of Ferguson and Kinloch and their resulting decline is well documented (Rothstein, 2015). Habitat fragmentation describes the emergence of discontinuities in an organism's preferred habitat, causing population fragmentation and ecosystem decline. Ananat found that the extent to which the American network of railroad tracks, laid out in the 19<sup>th</sup> century, physically subdivided cities strongly predicts the degree of racial segregation within a city. It is potential for railroad tracks to separate the poor and racial minorities from the rest of the city that gave rise to the term “wrong side of the tracks” (Ananat, 2015).

In the 1950s the construction of the Interstate Highway System was utilized as a blight clearance tool. Highways were consciously constructed through lower income, particularly African-American neighborhoods (Mohl, 2005). These neighborhoods lacked the political and economic power to insure the protection of their neighborhoods from habitat fragmentation due to the disturbance of this construction.

In addition to affecting immigration rates, isolation can also affect extinction rates. Populations on islands that are less isolated are less likely to become extinct because individuals from the source population and other islands can immigrate and rescue the population from extinction. This is known as the rescue effect (Figure 11). It is not surprising, therefore, that many shrinking cities, in danger of extinction, increasingly view immigration as a potential solution to their problems (Jackson, 2011). As vacancy increases in shrinking cities, the isolation of *Homo sapiens* habitat increases as the patch of urban development become increasingly smaller. An example of the rescue effect among populations of *Homo sapiens* is the restoration of the historically German neighborhood of Bevo Mill in south St. Louis by the influx of Bosnian refugees (*The Economist*, 2015).



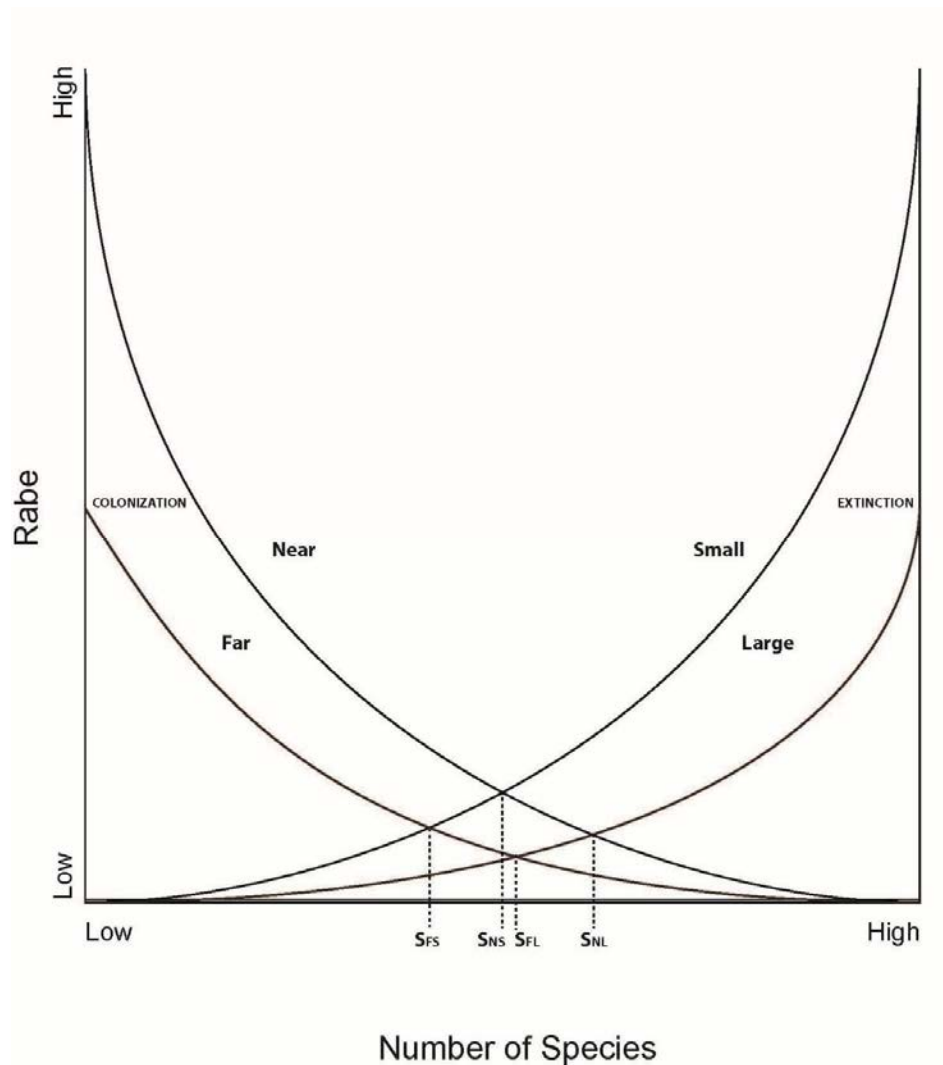


Figure 11: Rescue Effect - This diagram describes the relationship between colonization and extinction

In addition to affecting extinction, island size can also affect immigration rates. Species may actively target larger islands for their greater number of resources and available niches (Figure 12). Larger islands may accumulate more species by chance just because they are larger. This is known as the target effect (MacArthur, Wilson, 1967). An urban application, viewed in this light, suggests that larger cities are more attractive targets for *Homo sapiens* habitat because of their greater number of

resources and available niches. Shrinking cities are simply less attractive targets (Figure 12).

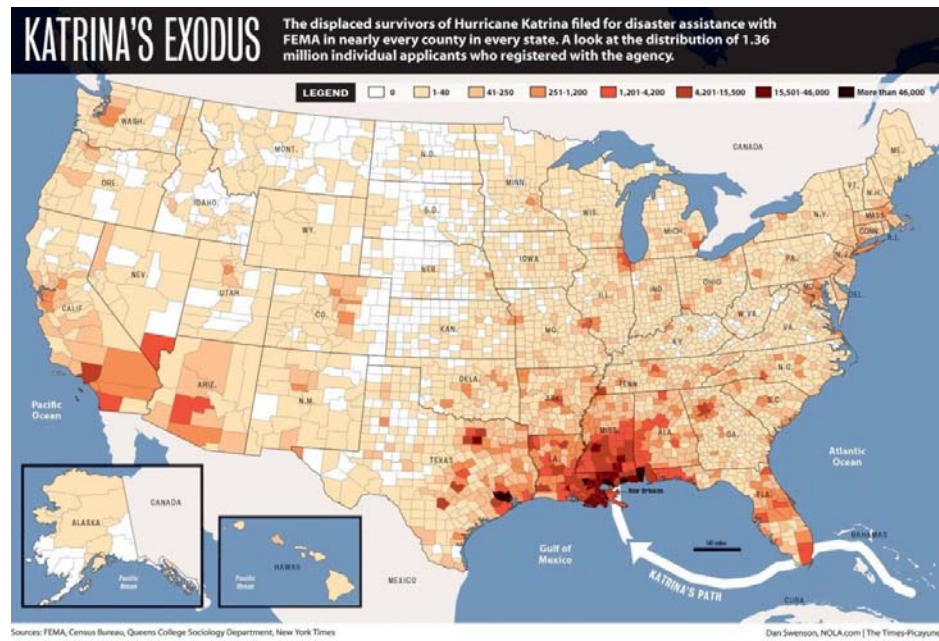


Figure 12: Katrina Exodus

As New Orleans has declined in population following Hurricane Katrina, Houston and other cities have become targets for the displaced population (Sastry and Gregory, 2014). Articles regularly list the fastest growing cities in the United States, effectively highlighting those cities which are subject to the target effect.

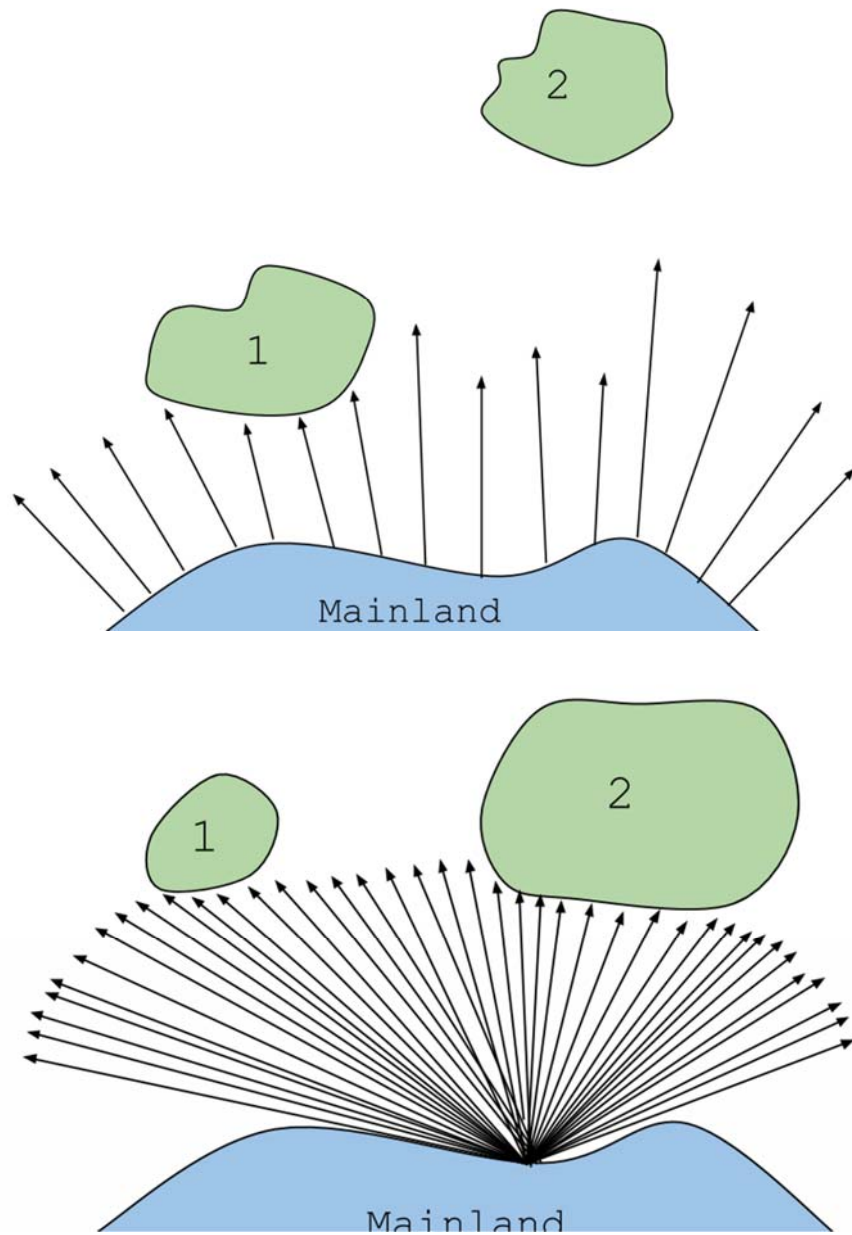


Figure 13: Target Effect (Distance Above/Island Size Below) The former effect illustrates how given two islands of similar size, the closer has the greater potential to attract more species. The latter illustrates how given two islands of equal distance the larger has the potential to attract more species.

Insular biogeography suggests that the number of species found in each habitat is determined by distance of isolation, length of isolation (time), habitat suitability (including climate and initial plant and animal composition, and the current species composition. Location relative to nutrient flows and serendipity (the impact of chance arrivals) can also have impacts on species richness and diversity. Shrinking cities are environments where the ‘nutrient’ flows of financial and *Homo sapiens* intellectual and social capital and innovation are in decline, and in fact demonstrate negative growth due to the outmigration of population.

### **3.3.2 The Theory of Patch Dynamics**

Related to island biogeographic theory is the theory of patch dynamics (Levin and Payne, 1974), a conceptual approach to ecosystems and habitat analysis that emphasizes dynamics of heterogeneity within a system. Under this concept, each area of an ecosystem is made up of a mosaic of small sub-ecosystems or patches. A habitat patch is any discrete area with a definite shape, spatial and configuration used by a species for breeding or obtaining other resources. Mosaics are the patterns within landscapes that are composed of smaller elements, such as individual forest stands, farms, or cities. Generally, larger patches are more capable of supporting a population of a given species. The validity of this principle for non-*Homo sapiens* species is well supported by considerable research (Forman, 1995). One might hypothesize that this principle holds true for *Homo sapiens* habitat as well. The disturbance like a major highway pushed through a residential neighborhood, such as in the construction of Interstate 10 in New Orleans or Interstate 64 in St. Louis, reduces patch size and can lead to decline of adjacent neighborhoods. While much research has examined the impact of *Homo sapiens* habitation on minimum patch size for a variety of other species, there are apparently no attempts thus far to define minimum patch size for *Homo sapiens*.

Home range is the area in which an animal lives and travels. It is related to the concept of “territory” which is the area that is actively defended. The concept can be

traced back to a publication in 1943 by Burt, who constructed maps delineating the spatial extent or outside boundary of an animal's movement during its everyday activities. Associated with the concept of a home range is the concept of a utilization distribution, which takes the form of a two-dimensional probability density function that represents the probability of finding an animal in a defined area within its home range (Burt, 1943). Efforts have been made to define the home range of Neanderthals ([www.nationalgeographic.com](http://www.nationalgeographic.com), 2015). Similarly, the International Union for the Conservation of Nature considers *Homo sapiens* to have the widest distribution or home range of any terrestrial mammal species, inhabiting every continent on earth (although there are no permanent *Homo sapiens* settlements on Antarctica) ([www.iucnredlist.org](http://www.iucnredlist.org), 2015).

*Homo sapiens* have been able to extend their home range through technology occupying more and more patches of habitat and displacing other species. *Homo sapiens* occupy every terrestrial biome on earth and are the keystone species in every ecosystem. Habitat loss for a species means that the habitat is no longer large enough to support the existing population. If this is true for birds and other mammals, this principle would logically follow for *Homo sapiens* as well. An understanding of the home range of a species aids in defining the minimum quantity of contiguous patches needed to sustain a population.

Patch size is nonetheless a consideration in evaluating *Homo sapiens* habitat. In this context, the concept of ecological footprint seeks to define a patch of sufficient size to support *Homo sapiens* population. This is a complex concept in the *Homo sapiens* context because transportation infrastructure, economic activities, and other considerations mean that patches must be economically and socially viable, not simply patches which are sustainable in terms of food production or the supply of homes. For designers seeking to strengthen existing urban neighborhoods or design new communities, understanding of the minimum patch size needed to support *Homo sapiens* population would be a valuable design parameter.

One could hypothesize that although not framed in biological terms, efforts throughout planning history to diagram or determine the ideal size of a neighborhood

are in fact an attempt to define optimum patch size for *Homo sapiens* habitation. In the 1920s, Perry introduced a concept that he referred to as “The Neighborhood Unit” (Perry, 1929). Perry illustrated the relationships between the residential components of a neighborhood and the uses that could easily be traversed to and from by foot. Perry utilized the 5- minute walk to define walking distances from residential to non-residential components. Perry’s diagram called for a site area of approximately 160 acres containing a community center, shopping districts around the perimeter, and a site for a place of worship. Central to the neighborhood was a school to which children could safely walk. He called for ten percent of the site to be set aside for open space.

Recognizing the ability for major roadways to delineate neighborhoods, Perry called for arterials to be placed at the perimeter of the neighborhood and internal roadways to be scaled to the needs of local traffic. The idea of quality neighborhoods containing all the necessary resources and facilities, and with the impact of major roadways at the perimeter has been a guiding principle of city planning for decades, yet all too often not realized within the fabric of American cities like New Orleans and St. Louis. Also he did not write in these terms, Perry seemed to understand the importance of minimum patch size and the dangers of habitat fragmentation.

Density and demographic characteristics can impact the land area need to support a school and the spending power of residents can determine the sustainability of a retail district, the general components of a desirable neighborhood have been defined in planning literature since the early 1900s. New Urbanism has evolved and updated the concept, but its fundamental component remains the same (Duany, Plater-Zyberk, 1999). Similarly, when a neighborhood lacks the population of economic resources to support a grocery store, locally serving retail, or a neighborhood school, one might hypothesize that it has fallen below minimum patch size needed to provide healthy *Homo sapiens* habitat.

Typically, patch dynamics consider the natural environment independent of the habitat of *Homo sapiens*. *Homo sapiens*, as another species within the environment, also contribute to the creation of patches through their actions. *Homo sapiens* often move through the environment at different times of their lives such as

courtship, child rearing, and retirement. From an urban perspective, patches are often comprised of one or more neighborhoods. Addicott stated that ecological neighborhoods represent regions of activity of influence during a given period appropriate to ecological processes. There is no single ecological neighborhood for any given organism, but rather several neighborhoods, each appropriate to different processes. Neighborhood size can be estimated by examining the distribution of activity or influence for an organism as a function of increasingly large spatial units (Addicott, 1987).

### **3.3.3 Disturbance Regimes**

Patches can move or change in part based upon disturbances, a temporary change in environmental conditions that can cause pronounced change in an ecosystem. Disturbances can be natural or manmade. Diverse patches of habitat created by natural disturbance regimes are critical to the maintenance of this ecological diversity. Natural disturbances include events such as floods, fires, earthquakes, tornados, pathogens, and hurricanes, together with vector-borne diseases and resulting epidemics. Both New Orleans and St. Louis have been heavily influenced during the courses of their histories by outbreaks of yellow fever, cholera, and smallpox. These various disturbances shift the pattern of patches across the landscape, often replacing the habitat of one species or of one group with another. A natural disturbance regime is distinguished from a single disturbance event because it describes a pattern of spatial disturbance, a frequency and intensity of disturbances, and a resulting ecological pattern over space and time. Flooding of the Mississippi River and hurricanes, when they hit the Gulf Coast of the United States, are examples of disturbance regimes.

Within the context of patch dynamics theory, the landscape is a mosaic of patterns composed of smaller elements, such as individual forest stands, farms, or cities. Patches are thus hierarchical. At the largest scale of analysis, one might argue that countries (*i.e.* political boundaries) create patches by often dividing watersheds and bioclimatic zones. The management challenges of water management in the



Colorado River between the United States and Mexico are one such example of how national boundaries can produce different management strategies within a given watershed. States and cities, and their defined boundaries, are, in turn, finer grains of patches. Cities, however, are further divided, often without defined boundaries, into neighborhoods or various types of open space and habitat and into smaller patches still by a wide variety of habitats or social customs. These social and ecological forces combine in myriad ways to create complex and often overlapping patch dynamics. The urban landscape is therefore a scaled hierarchy of nested ecosystems. For designers and urban managers seeking to right-size a shrinking city, the task is to determine the city's appropriate place within this scaled hierarchy. Attempts by designers to alter the complexity of these patches in a way that benefits *Homo sapiens* and ecosystem health and well-being present a truly challenging problem, often termed as being a wicked problem, one that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize or comprehend (Churchman, 1967).

Patch dynamics theory recognizes that all landscapes, including the urban landscape, are dynamic and in constant evolution. There are three states in which a patch can exist: potential, active, and degraded. Patches in the potential state are transformed into active patches through colonization of the patch by dispersing species or groups arriving from other active or degrading patches. Although no doubt a radical interpretation, gentrification is seen in this light as a form of active patch colonization. Some researchers have suggested that gentrification is a form of ecological succession (Fairchild, 2007). Ecological succession is the process by which the structure of a biological community evolves over time.

Similarly, what is often known as neighborhood change, in which a poorer economic class occupies a neighborhood (or patch) formerly occupied by a higher economic class, is patch colonization by a group in search of more suitable habitat. Such change is not patch degradation because the patch still supports *Homo sapiens* habitation. Patches are transformed from the active state to the degraded state when the patch is abandoned (the common condition of shrinking cities), and patches change from degraded to potential through a process of recovery. In the case of degraded or

vacant patches in shrinking cities, non-*Homo sapiens* species often fill the habitat once occupied by man.

Although the mosaic of landscape patches is constantly shifting and evolving, some patches have more persistence or have greater duration in the landscape than others. Disturbances have less impact upon some patches and can in fact increase habitat quality for some species while disturbances can degrade patch quality.

In New Orleans, areas like Lakeshore and the Garden District have been persistently high optimum habitat for decades if not centuries. Other areas such as the Broadmoor neighborhood, and the Lower Ninth Ward have struggled as persistently marginal habitat for over a century (Figure 14).

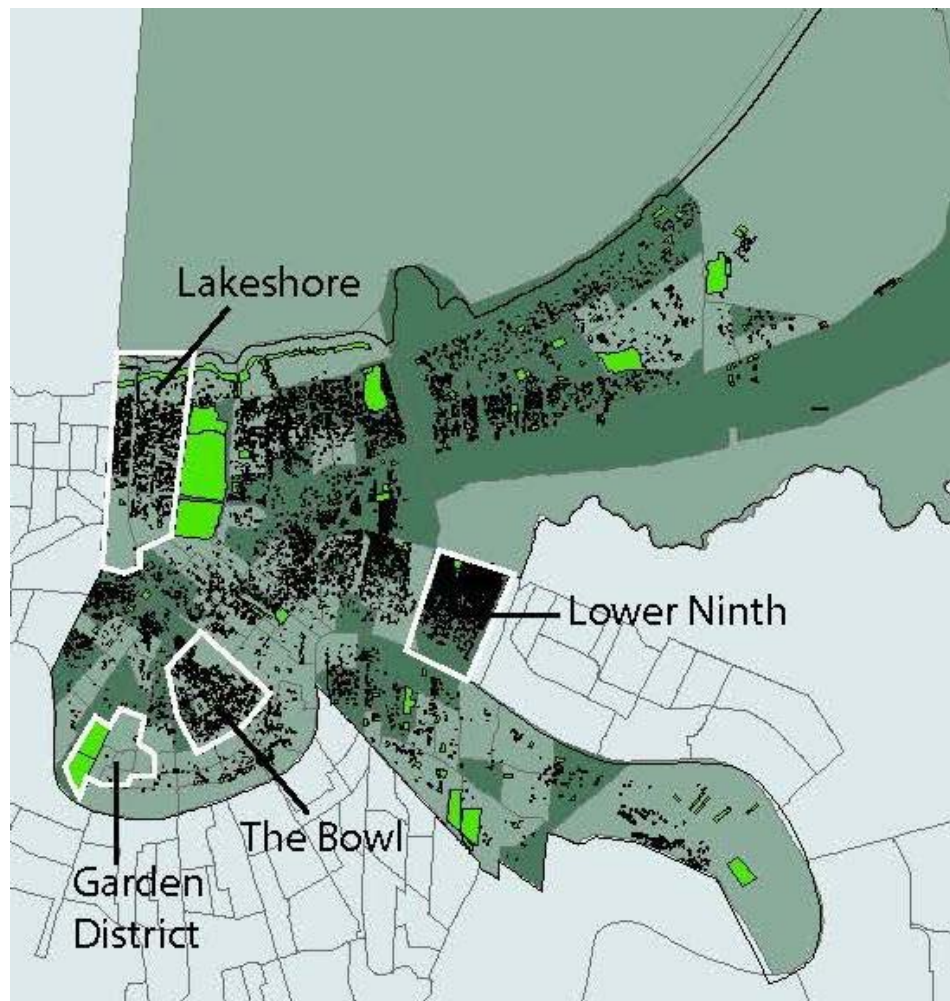


Figure 14: Habitat Patches of New Orleans

In St. Louis, the Near North Side legislated via racial covenants and redlining as a predominantly black area of the city has struggled economically for over a century, while Millionaire's Row which border's the city's major park, Forest Park, has been a prime address for an equal time (Figure 15). Time lapse sequences in the Appendix (E.4) illustrate the persistence of these patches in New Orleans and St. Louis over time. Persistence can be defined as stability in the face of change in ecosystem variables. Persistence can be found in high quality habitat, as in the case of Millionaire's Row, and in poor quality habitat, as in the case of the Near North Side which has remained largely constant in terms of economic and social conditions since at least the 1940s.

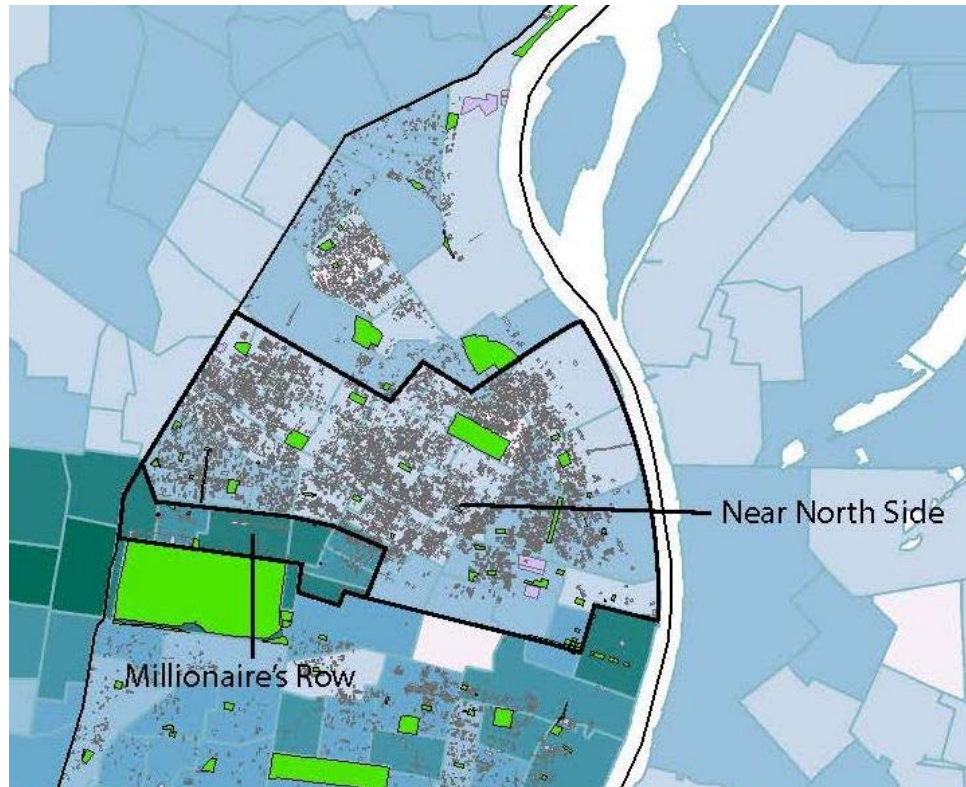


Figure 15: Habitat Patches of St. Louis

### 3.3.4 Urban Metabolism

The concept of metabolism developed in the 19<sup>th</sup> century to characterize chemical changes in living cells and applied in the last fifty years to represent process of organic breakdown and combination, within individual organisms, and between organisms and their environment. Leibig used the term to describe the material exchanges and interdependent relationships between *Homo sapiens* society and nature.

Marx was the first to use the concept of social metabolism to question the apparent separation between the *Homo sapiens* and their environment, the society-

nature duality, which Marx coined as metabolic rift. The term metabolic rift referred to the notion that *Homo sapiens* in capitalist society have become estranged from the natural conditions of their existence.

In 1965, Wolman published the first explicit application of the metabolism concept to the urban sphere. Wolman defined metabolic needs as “all the materials and commodities needed to sustain the city’s inhabitants at home, at work and at play.”

Contemporary work employing the concept of urban metabolism tends to draw on either biophysical or political economy. Urban ecology understands the city as an ecosystem in the biological sense, seeing the city as both a system and a natural entity. The city is an ecosystem embedded in a larger system, and the metabolism notion is used to describe the interactions between the numerous subsystems of an urban region, to understand how cities process energy or matter in relation to their surroundings. Accordingly, urban ecologist proponents argue that by emulating the cyclical and efficient nature of natural ecosystems, that is, by shifting from a linear to a circular metabolism, in which outputs are recycled back into the system to become inputs, urban settlements will become viable and sustainable in the long term (Rappaport, 2011).

In this vein, a group of scholars working in the subdiscipline of systems ecology have developed research to understand cities as socio-ecological systems; i.e. urban ecosystems (Golubiewski, 2012). According to these scholars, working from complex system theory, “urban ecosystems are complex, dynamic biological-physical-social entities, in which spatial heterogeneity and spatially localized feedbacks play a large role.” Urban metabolism studies seek to develop methods that improve the metabolic efficiency or to reduce the amount of resources used per unit of economic output, a process referred to as dematerialization or decoupling (Carpintero, 2015).

The ecological economics and political ecology disciplines share a common interest in the unequal social and ecological distributional flows and structural

inequalities that unfold within the functioning of cities. These scholars relate urban agglomeration resource demands to the structural inequalities and ecological conflicts occurring in the regions supplying these resources. Within ecological economics two perspectives appear. The first seeks to explain the connections between urban flows and inequality by supporting the idea that cities are both centers of capital accumulation and dissipative structures or systems sustained through increasing resource exchanges within their peripheral environments. This ever-increasing exchange process is the main cause of the creation of continual structural inequalities between urban areas and their periphery. The underlying ecological conditions of *Homo sapiens* economies determine this unequal distribution of resources. This relates to and builds on Harvey's proposals of the "uneven geographical development" of capitalism, which emphasizes the significance of the politics of space and the role of space in social reproduction, mainly in the urban context, as well as the property rights in land markets shaping the physical landscape of spatial accumulation driven by the capitalist mode of production (Harvey, 2006). Since urban metabolic processes rely on areas beyond their boundaries, these processes produce and reproduce inequality through conflicts around the social and environmental costs of resource extraction.

### **3.3.5 Design of *Homo sapiens* Habitat**

The view of cities as ecosystems has evolved over time. Architect Leon Battista Alberti's treatise *On Architecture*, written in the mid- fifteenth century advocated that the siting and design of cities be adapted to the character of their environment so that cities might promote health, safety, convenience, dignity, and pleasure. Philologist George Perkins Marsh repeated this warning several centuries later, when he predicted that "human improvidence" was reducing the earth "to such a condition of impoverished productiveness, of shattered surface, of climatic excess" as to threaten the "extinction of the species" (Marsh 1865). Marsh's contemporary, Frederick Law Olmsted, sought to "hasten the process already begun" by nature, thereby achieving more than the "unassisted processes of nature" (Olmsted and Vaux 1887, Spirn 1995).

By the beginning of the twentieth century, some disagreed over whether the task was to rebuild existing cities or to build new “garden cities” in the countryside, such as those advocated by the English author Ebenezer Howard [1850-1928]. Scotsman Patrick Geddes [1854-1932] opposed Howard’s approach (Geddes 1915). Geddes viewed each city and its surrounding countryside as an evolving organic whole whose future should be based on an understanding of its natural and cultural history and its “life-processes in the present” (Geddes 1915: 2).

As the thinking of anthropologists and biologists regarding the place of *Homo sapiens* and the city evolved, so did theories of urban form. In the 1920s Park and Burgess tried to create a model that could explain the form and growth of the city (Park and Burgess, 1925). Deploying an organic metaphor, they described this process as “ecological.” Per Park and Burgess, successive waves of people and activities moved from central locations into an adjacent neighborhood farther out from the city core and eventually dominated them, only to be replaced by the next wave. They illustrated this process by a diagram of the city as a series of concentric circles (Figure 16). In this drawing, the inner circle contained the central business district; a loop transportation system, and its environs. Beyond this a zone in transition, an area that housed many of the city’s poorest residents in communities was being invaded by business and light manufacture. Farther out still laid a third ring, consisting primarily of housing for the working class who had escaped the deterioration closer to the center. This was followed by a fourth ring of single-family residential areas, and finally, a “commuter zone” of suburbs and satellite cities located from thirty to sixty minutes from the central business district.

Many studies of urban settlement view cities as a “climax” stage of *Homo sapiens* succession, like the latter stages of forest development. According to Park, the subject of *Homo sapiens* ecological research consisted of biotic relationships: competition for space lead to the formation of cooperative bonds or symbiotic relationships. As these change over time and space, successional forces come into play, dominance changes, and groups invade either unoccupied or deteriorated areas. Park believed that the biological concepts of competition, dominance, invasion, and succession were applicable to *Homo sapiens* organization and behavior in cities.

(Moran, 1979). As Ratzel had done, Park was describing the contested landscapes of the urban ecosystem.

The instincts of Park and Burgess that cities behaved in an ecological fashion were well-founded. However, what we know today about the dynamic nature of ecosystems suggests that a formal, deterministic model of urban form is misguided.

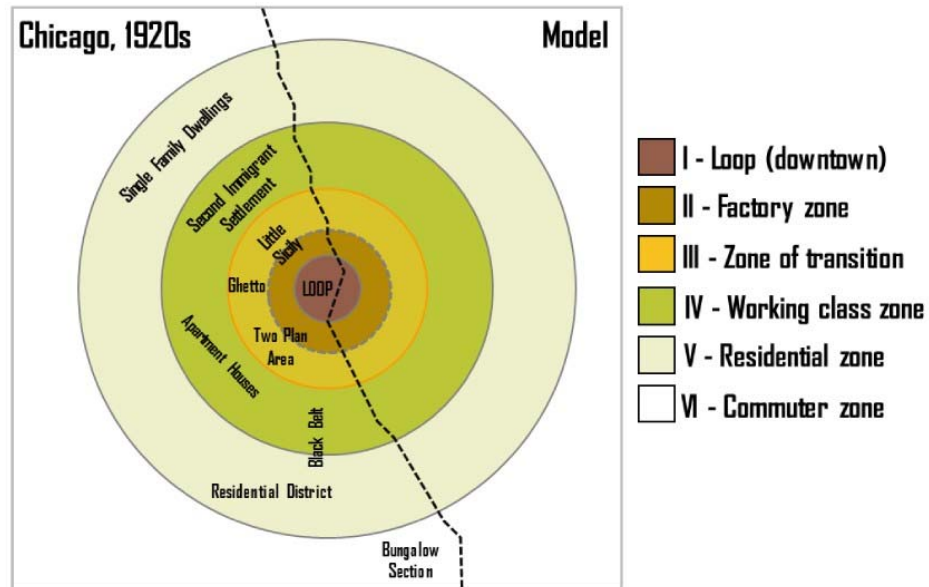


Figure 16: Park-Burgess Model

One attempt to correct the problems of the Park-Burgess model to account for the diverse population within each zone and the asymmetrical way that the city developed was a variation of a diagram developed by Homer Hoyt in the 1930s (Hoyt, 1939). In his “sectorial” model, Hoyt retained the basic dynamic of ecological succession, with residents constantly moving farther out as they were able, but Hoyt chose to segment the urban area into different pie-shaped wedges that behaved quite differently, one from another (Figure 17). Although it did succeed in considering several important features of urban life that were not visible on the Park- Burgess diagram, it was still unable to incorporate others. One of the most crucial was the growing evidence that urban development was not, as Park and Burgess or Hoyt had assumed, unidirectional, that is, with affluent people always moving farther out. Hoyt’s notion of sectors,



each of which behaved differently was one step toward the conceptualization of a city as a mosaic of dynamic patches, but it stopped short of this idea. His concern for the asymmetrical development of the city, foreshadowed the interest of urban political ecologists in uneven development, characterized by persistent differences in the level and rates of economic development.

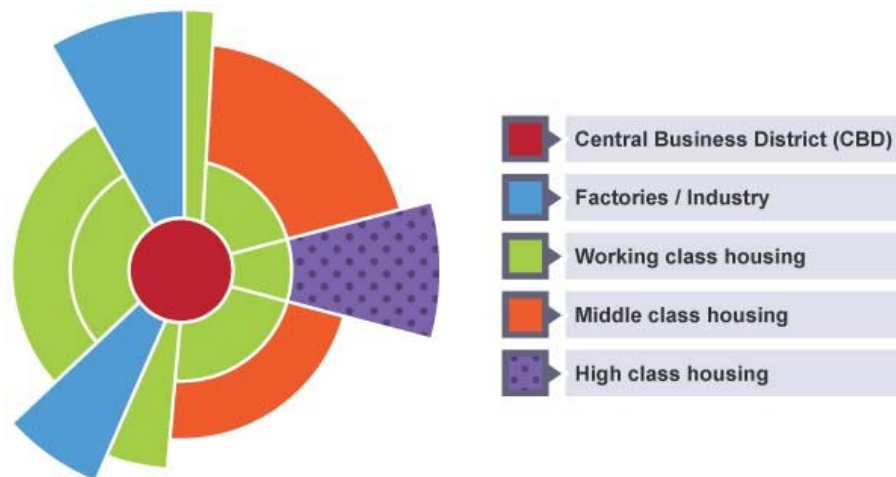


Figure 17: Diagram of the Homer Hoyt Model

During the post-war years, problems with the old Park-Burgess concentric circles became ever more apparent. The best-known attempt to portray the dispersal and regrouping of activities appears to be a “multinucleated” model created by geographers Chauncey D. Harris and Edward L. Ullman immediately after World War II (Figure 18). The Harris-Ullman model, however, was soon seen to be inadequate because it assumed that each city, with all its peripheral development, was a discrete entity. The model did not account for the tight clustering of cities that often formed a single urban region. The resulting pattern of intersecting urban, suburban, and exurban rings was much more complex than anything any of the previous models had indicated. This complicated and constantly shifting metropolitan pattern was described by the geographer Jean Gottmann, who coined the term “megalopolis” to describe the vast multi-centered conurbations.

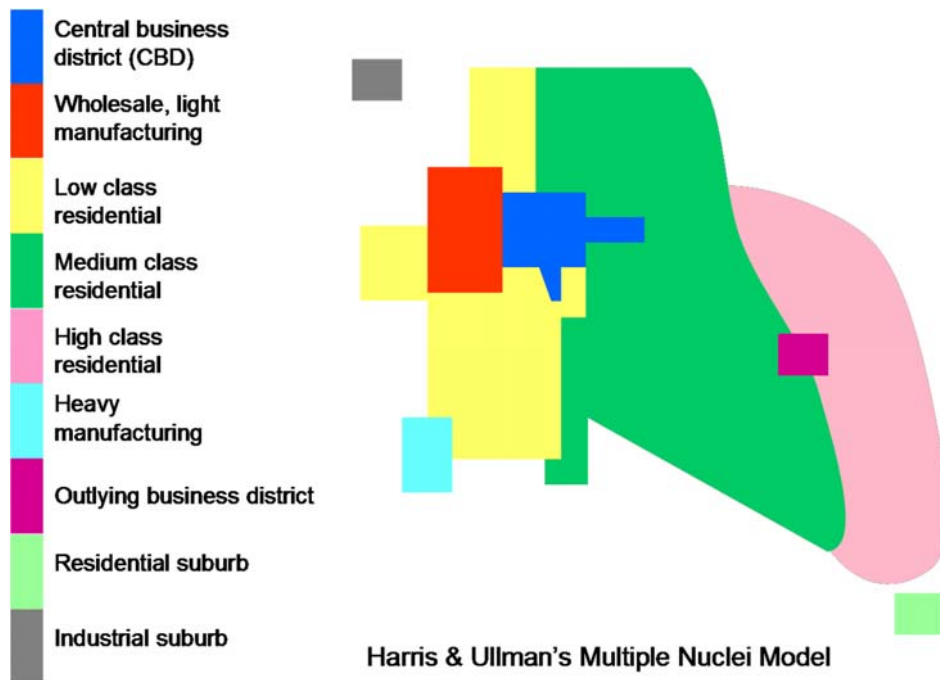


Figure 18: The Harris-Ullman Model

The boom in affluent populations at the core of American cities has been made possible in part by the rapid development of the condominium form of ownership since the 1960s. Change in ownership law, like other management changes, is also a disturbance.

Land consumption also increased as, single-family houses have become much larger than they were in the post-war decades, as the average size of a new house has mushroomed from around 1000 square feet at the end of the war to nearly 2,500 square feet by the end of the century. Many of the new subdivisions, also explored new forms of internal governance, particularly using homeowner associations that have come to provide a kind of private local governmental structure. The homeowners' association boundaries, particularly those of gated communities, further subdivide the landscape into patches. In addition, an increasing number of new residential communities have

been gated. These gated communities represent yet another example of how management activities of *Homo sapiens* divide the landscape into patches.

Since much of the increase in land area was due to new houses, the more appropriate statistic would logically have been the increase in the number of households. Throughout America, during the years when the baby boom generation matured, household sizes declined rapidly. Nationwide the number of persons per household sank from 3.14 in 1970 to 2.63 in 1990. This suggests a rapid expansion in the need for housing even without a growth in population.

The average household size in the New Orleans metro has been falling for several decades and continued its decline from over 2.75 in 1980 and 2.59 persons per household in 2000 to 2.52 persons per household in 2010 (The Data Center, 2016). The average household size in St. Louis in 1950 was 3.1 and in 2010, 2.2. With every other factor held constant, the decrease in city population would have been 248,000, or 29%, over this period. This means that with the same number of homes and apartments, and with the same number of families that resided in the city in 1950, the decrease in average household size could account for 46% of the city's population loss (Ihnen, 2014).

Although Jean Gottmann's 1961 concept of the megalopolis has proven more satisfactory, a more recent metaphor, the "galactic metropolis" as used by geographer Pierce Lewis (Lewis, 1979), provides another way of thinking about these areas. Using this metaphor, we can set aside the traditional distinctions between urban, suburban, and rural and think instead of settlements across a vast landscape each exerting a target effect, stronger, or weaker per their size and density, and changing in intensity across time. Gottmann's diagram suggests a series of large patches each representing a major urban area, consistent with the idea of a nested hierarchy of ecosystems (Figure 19).

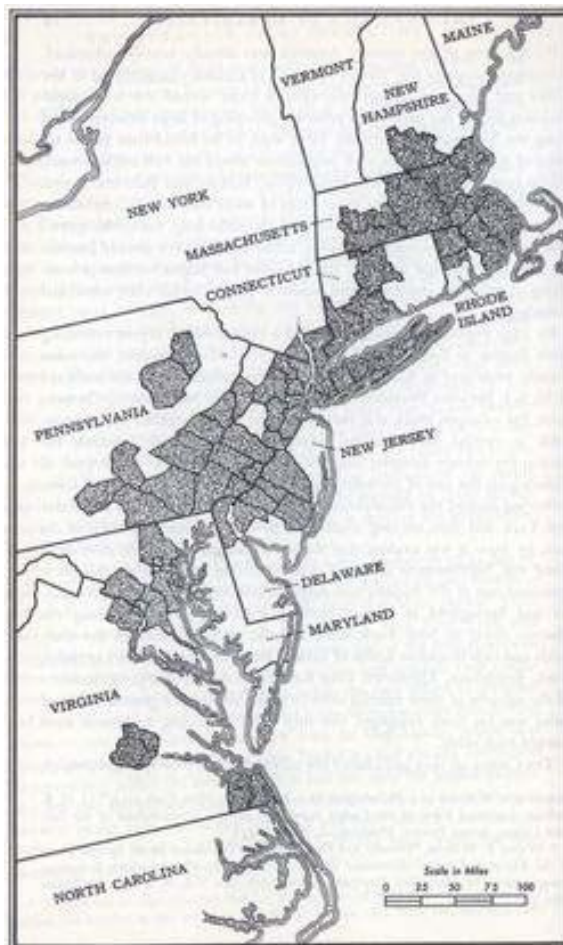


Figure 19: Gottman's Megalopolis

Patch dynamic theory would suggest a diagram of urban form that is more similar to a Voronoi patch though the patches would be dynamic over time, some would remain fairly constant or persistent over time, others would change shape or contain different groups or land uses such as residential, retail, or industrial (Figure 20).

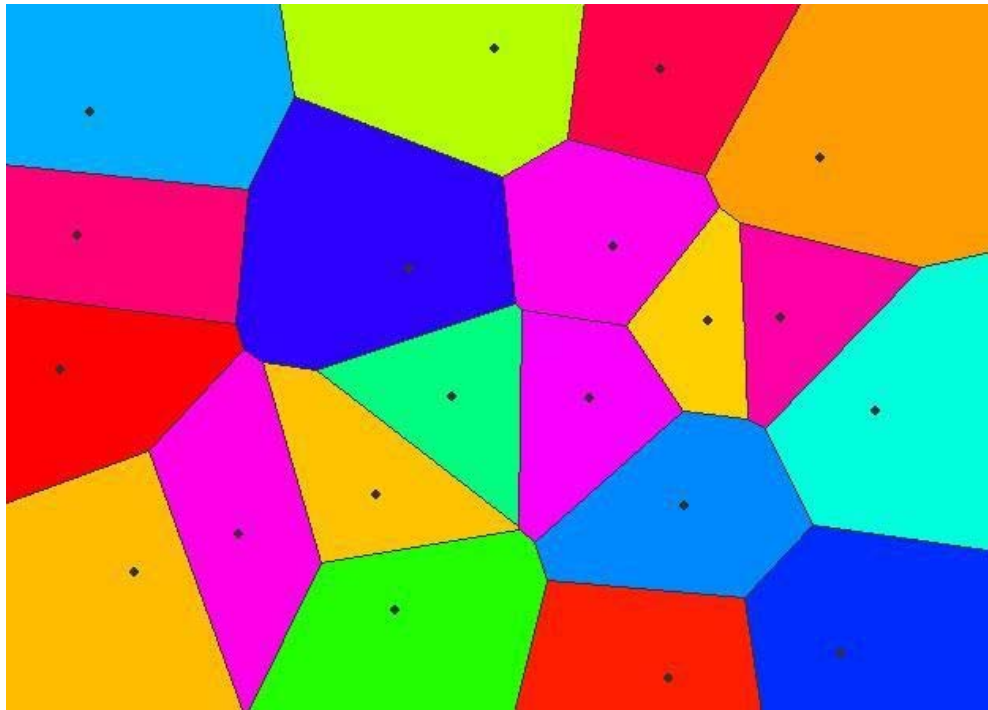


Figure 20: Voronoi Diagram

Mumford [1895-1990], like his mentor Geddes, promoted an integrative approach to cities and their regions (Mumford, 1968). Mumford influenced Lynch [1918-1984] and McHarg [1920-2001]. Lynch and McHarg shared the conviction that cities must be viewed in their regional context and that the natural environment has a social value to be cultivated in urban design.

Environmental adaptability was of concern to Lynch (Lynch, 1958). Lynch argued that general adaptability in an environment was enhanced where major structure is concentrated, and where functional areas are separated in a rather coarse grain, particularly where the likely-to-change or easy-to-change features can be distinguished. He also saw value in a city form that was additive in nature, where growth units at the periphery did not change the structure at the center. This is the problem of preserving resources for future generations; the issue of how much present

effort can be diverted to such preservation. The most persistent of *Homo sapiens* settlements, Lynch observed, have been the large and complex ones.

Lynch believed that a loose, shifting, temporary world may be ideal for meeting major changes in man's circumstances, and for allowing his development without hindrance. But not only may it not be most suitable for the active promotion of development, and not only may it be relatively inefficient for present function, it may simply not be a very happy place for *Homo sapiens* existence. Adaptable forms are likely to be ambiguous, unclear, shifting, discontinuous. Thus, there is likely to be a conflict in basic objectives. Lynch believed that we can do little more than to point out the conflict, which is indeed the basic problem of any system, and particularly of any *Homo sapiens* society, how to provide continuity and clarity of form and of aspiration, without hindering the flexible adjustment of function to the constantly changing situation. Lynch judged "good city form" by how well it sustains *Homo sapiens* life (Lynch, 1981), or in other words, supported fitness.

Like Geddes, McHarg asserted that "any place can only be understood through its physical evolution" (McHarg, 1967). As a prerequisite for design, he advocated an ecological inventory, a checklist of interrelated systems useful not only to understand how a place came to be but also as a diagnostic tool with which to identify problems and opportunities that might otherwise be missed (Spirn, 2000). For McHarg, design was a means of adaptation and an evolutionary strategy.

McHarg's work provided the foundation for that of Steinitz (Steinitz, 2012). Their work and development of geographic information system led to the development of geodesign, an approach which generates design proposals coupled with impact simulations and informed by geographic context.

For Jacobs, as for McHarg and Lynch, "human beings are ... part of nature" as are cities (Jacobs, 1961). Like Lynch, she focused on the city as a human habitat and regarded urban design to support and fulfill human needs. Jacobs advocated an

ecological approach to designing and managing cities, arguing that cities are problems of organized complexity, akin to living organisms. She argued that there are lessons for urban design from the study of systems where “half-dozen or even several dozen quantities are all varying simultaneously and in subtly interconnected ways.” (Jacobs, 1961).

Spirn’s *The Granite Garden: Urban Nature and Human Design* (Spirn, 1984) argued that cities are part of the natural world, and she sought to demonstrate how cities can be designed in concert with natural processes. Hough’s *City Form and Natural Process* further elaborated on these concepts (Hough 1984).

John Lyle first sought to merge an understanding of ecosystems with design in 1985. He argued that designers must understand the ecological order of structure, function, and location. A year later Forman published Landscape Ecology, (1986) describing a conceptual framework of patches, corridors, and matrix which shaped the landscape.

### **3.3.6 Structure and Agency**

Political and social science researchers often debate whether society is shaped by structure or by agency. Structure usually refers to the societal structures such as systems, institutions, power-relationships, and laws which define the range of actions available to actors. Homo sapiens operate on these structures -building, modifying, and removing them. Agency is the ability of individuals or groups (intentional or otherwise) to affect their environment by operating on these structures by building, modifying, or removing them. This debate relates to the fundamental issue of determinism versus free will -to what degree we products of our environment as against our ability to determine our own future.

This research takes the position that the fate of individuals is determined by more than structure. That is, they can influence their future through individual decisions and actions. An example of such a decision would be the selection of a place

to live. An individual can generally choose to live anywhere within the City of New Orleans or St. Louis, to find the highest quality habitat, that is within their financial means. Studies which reflect the hedonic value of consumer choices in housing location seeks to explain the impacts of these individual choices and actions. Conversely, it can be that structure, such as institutionalized racism, can severely limit one's choices and range of actions. It was not until the Fair Housing Act of 1968 in the United States that discrimination in housing based on race, sex, religion, or national origin was prohibited by law. Prior to that time, actions such as racial zoning, racial covenants, and red lining, severely limited the housing choices of many residents, particularly African-Americans.

This research thus takes a dialectical approach: agency affects structure and structure also affects agency. How opportunities and risks are assigned or apportioned is a product of the interaction between structure and the institutions which support it and the agency of individuals and groups.

Choosing a Marxist perspective, the proponents of urban political ecology argue that in practice it is hard to see where "society" begins and "nature" ends. Harvey argued there is nothing unnatural about New York City (Harvey, 1993). Marx argued that nature is incomprehensible except as mediated by social labor. Urban political ecology seeks to eliminate the separation of nature and society, arguing that cities are produced through socio-ecological processes, with urban conditions made through the political process. Swyngedouw (1999) suggests that natural or ecological conditions and processes do not operate separately from social processes, and that the existing socio-natural conditions are always the result of intricate transformations of pre-existing configurations that are themselves inherently natural and social. Urban political ecology combines the concerns of ecology and a broadly defined political economy. Together this encompasses the constantly shifting dialectic between society and land-based resources, and within classes and groups within society itself. Schmink and Wood (1987) propose that political ecology should be used to explain "how economic and political processes determine the way natural resources have been exploited." Such a framework begins to disentangle the interwoven knots of social



process, material metabolism, and spatial form that go into the formation of contemporary urban socio-natural landscapes (Swyngedouw and Heynen, 2003).

From this perspective, there is no such thing as an unsustainable city in general, but rather there are a series of urban and environmental processes that negatively affect some social groups while benefiting others (Swyngedouw and Kaika, 2000). Urban political ecology research has begun to show that because of the underlying economic, political, and cultural processes inherent in the production of urban landscapes, urban change tends to be spatially differentiated, and highly uneven. The field attempts to tease out who gains and who loses (and in what ways), who benefits and who suffers from processes of socio-environmental change (Desfor and Keil, 2004). In other words, environmental transformations are not independent of class, gender, ethnicity, or other power struggles. These metabolisms produce socio-environmental conditions that are both enabling, for powerful individuals and groups, and disabling, for marginalized individuals and groups. Processes of socio-environmental change are, therefore, never socially or ecologically neutral. This results in conditions under which trajectories of socio-environmental change undermine the stability of social groups or places while sustainability of social groups and places elsewhere might be enhanced. It is this nexus of power and social actors deployed or mobilizing these power relationships that ultimately decide who will have access to or control over, and who will be excluded from access to and control over, resources or other components of the environment.

Echoing Marx, Neo-Marxist theoreticians, such as Smith and Harvey, suggest that capitalism can never achieve the equilibrium between production and consumption which it desires. The free market and laws of competition create dynamism and instability, with producers constantly searching for new markets and opportunities, for cheaper materials and labor, and for real estate deals. This dynamism, instability and absence of equilibrium of capitalist markets results in uneven geographical development (Smith, 1984).

While these theoreticians recognize that different natural resources, different geographical locations, and proximity to raw materials are important influences on

development patterns, the importance of these factors has diminished over time. These natural conditions are surpassed by other factors including the availability of labor, means of transportation and production, and regulations and controls (Kaminer, Robles-Durán, and Sohn, 2011). Such a view recalls Marx's edict that "men make their own history, not of their free will; not under circumstances they themselves have chosen." (Marx, 1852). Marx seems to suggest that while agents shape the world they inhabit, the context or circumstances in which this occurs affects their ability to do so.

Kaminer suggests that crises are recurring and fundamental phenomenon of the capitalist mode of production and are the result of the impossibility of reaching equilibrium of supply and demand. Crises are a means of social and economic reorganization and of redistributing labor according to the means of production. They are related to a transformation of the political economy and as such can mark a change in the type of urban development and in urban morphology (Kaminer, Robles-Durán, and Sohn, 2011). From an ecological perspective, crises such as the Great Depression of 1929, or more recently the Great Recession of 2008, are considered a form of disturbance. Similarly, the scaling back of the social programs of Johnson's Great Society under Nixon are another form of disturbance for cities like New Orleans and St. Louis.

Plumwood (Rose, 2001), Foltz (Foltz, 2003), Nash (Nash, 2005), Davies (Davies, 2009) Wegner (Wegner, 2002) offers another perspective on *Homo sapiens* agency. Plumwood challenged the duality of man/nature and argued that the entire living world possessed its own agency and sentience. Foltz argues that *Homo sapiens* at all times interact not just with other *Homo sapiens* but at all times, places, and contexts with the non-human world as well. He argues that nature possesses agency. Nash argues that the concept of agency, even when constrained by structure, is too simplistic to describe what took place and assigns too much power to a supposed rational center.

Drawing on the work of Wegner, Davies, suggests that mechanisms involved in vision, memory, and dreaming are proven to be products of anticipatory, systematic functions. The presence of these low-level, nonconscious mechanisms challenge us to

divest the traditional concepts of purpose and function associated with agency. Many vital physiological and psychological capacities operate beyond reach of conscious awareness. At some level, choices regarding habitat may operate beyond the reach of our conscious awareness and thus beyond the boundaries of traditional definitions of agency and structure. Davies states that a view of agency that fails to account for the apparent facts of human freedom – including our overweening confidence that sometimes we are unfettered centers of command and control – is a failed view. Davies concludes that we do not know what kind of agents we are. We do not know what kind of freedom, if any, we have. If we accept the positions of Plumwood, Foltz, Nash, Davies, and Wegner, then the actions of *Homo sapiens* relative to their environment are influenced by the agency of nature and by instinct, like other species. This thesis takes the perspective that while much of the contestation for urban habitat are determined by agency and structure, naturalism is also a factor in this contestation.

Landscapes evolve continually in time, in predictable and unpredictable ways, and in response to natural processes and changing *Homo sapiens* purposes. The forms on the surface of the landscape are a sum of all these processes, both natural and cultural. This surface structure is thus in flux. Underlying the surface, however, there is a more enduring structure to which all organisms within that landscape respond. Spirn stated that this deep structure expresses the fundamental climatic, geomorphic, and biotic processes in a place. (Spirn 1993). Lyle called for the creation of deep form, and he argued that this has the potential for timelessness, creating a landscape structure that reflects less visible but essential processes, accommodates change, and remains profound over time (Lyle, 1985). In Lyle's view, landscapes that give visible expression to the processes that shape the earth and make a connection between nature and *Homo sapiens* culture can be described as having deep form. In contrast, shallow form is a purely visual, stylistic creation that hovers on the surface of the land without connecting to nature's ongoing processes. In his distinction between deep and shallow form, Lyle challenges design professionals to consider the purpose and significance of their work.

Not all features of the urban natural environment are equally significant. While some are ephemeral, others are more enduring, and while urbanization radically changes the surface of the landscape, the deep structure of a city is expressed in that city's climate, geology, and physiography. Deep structure remains crucial to the history and future of a place – why it was settled, its initial location, its transportation routes, its economic development and population distribution, the character of its buildings, streets, and parks, and the health and safety of its residents. Vegetation is considered ephemeral. Despite aesthetic value and important ecological services, the historical vegetation patterns of a city are often obliterated. Little or no old growth forest (characterized by trees at least 150 years of age) remains in either New Orleans or St. Louis. Cities should be designed in agreement with the deep structure of a region, rather than counter to it, as this strategy is essential to fostering resilient urban form.

Spirn argues that deep structure can be masked, but it cannot be erased. When surface structure obscures or opposes deep structure, it will require additional energy, materials, and information to sustain. If these resources cease to be applied, in the case of New Orleans funding for pumping and levee systems, the deep structure will reassert itself. (Spirn, 1993).

Developing the Mill Creek valley of St. Louis or the construction of residential neighborhoods in New Orleans on the back swamps between Claiborne Avenue and Lake Pontchartrain are examples of development not in concert with the deep structure of the city. In contrast, urban form that reveals and responds to deep structure is likely to be more functional, more economical, and more resilient than design that disregards it. This is especially important for the design of the infrastructure (water, sewer, power, transportation) that supports the city, whether at the scale of building, neighborhood, city, or region (Spirn 2000a and 2005, and Philadelphia Water Department, 2009). Such design may also afford an aesthetic experience of unity with the processes which shape the landscape, and which sustain life (Spirn, 1988, Brown, 1998, Meyer, 2008, Bergmann, 2011, Miss, 2012).

As a function of their deep structure, cities are prone to specific natural hazards whose precise timing is unknown (Cutter, 2001). Historical examples provide

lessons of failure and success (Vale and Campanella, 2005). The rise of the nation-state which has a vested interest in the well-being of its cities is one key to recovery. Certainly the \$2 billion in disaster relief the United States poured into New Orleans is evidence of this. The establishment of the modern insurance industry is another, as insurance payments encourage property owners to rebuild in place. Hurricanes Katrina and Rita resulted in a combined \$41 billion settlement in Louisiana - \$25.5 billion for Katrina and \$3.5 billion for Rita excluding flood losses! A total of 725,000 claims were filed following Katrina and 205,000 from Rita.

Hurricane Katrina was the worst insured loss event in the history of insurance anywhere in the world (Jones, 2015). The presence of a substantial infrastructure network also facilitates rebuilding. The geographic and economic factors that led to the city's formation in the first place are also a factor. Vale and Campanella argue that a key to rebuilding a city impacted by natural disasters is social infrastructure, the myriad familial, social, and religious relationships that allow recovery to occur. An understanding of a city's resiliency must include, therefore, geophysical and economic conditions but the social condition as well.

### **3.3.7 Management and *Homo Sapiens* Ecosystems**

Lyle in Designing for Human Ecosystems (Lyle, 1985) suggests that management activities are one way in which *Homo sapiens* influence their ecosystem. It is management, for example, that allows world heritage- designated cities like Edinburgh (Zappino, 2010) and Venice (UNESCO, 2012) to maintain their built environment with very little visual change while the social and demographic makeups of their populations migrate and evolve within this constant physical framework. But management decisions, particularly when made for ideological instead of utilitarian reasons, are a form of disturbance. Decisions motivated by racism have profoundly shaped New Orleans and St. Louis. For example, United States Supreme Court rulings such as *Plessy v. Ferguson* in 1896, a lawsuit brought in New Orleans which upheld the principle of "separate but equal" in public facilities until overturned in the case of *Brown v. Board of Education* of Topeka in 1954. Consistent with the theory of insular

biogeography, *Plessy v. Ferguson* contributed to the isolation of African Americans into separate facilities for schools, public transportation, and public accommodations for six decades ([www.history.com](http://www.history.com), 2016). Management imposes structure and reduces the choices of individual agents.

Lyle further argues that the inclusion of management is particularly important in ecosystem design because of the variable future that is a fact of life for any organic entity. Management deals with this uncertainty in the cybernetic manner by observing what happens and redesigning as necessary. For this reason, the interlocking nature between design and management is particularly important in ecosystem design.

Merriam-Webster defines design as “to create, fashion, execute or construct per a plan ([www.merriam-webster.com](http://www.merriam-webster.com), 2016). Design may be applied to objects, systems, or measurable *Homo sapiens* interactions. In that regard, design is a form of management. Similarly, design and subsequent design execution is a form of disturbance, with either negative or positive effects. Although designers and planners generally view their efforts as well-intended and beneficial to the *Homo sapiens* condition, design interventions are disturbances as well. A disturbance in this context need not be negative, but rather might simply be any event or action that results in the reordering of patches or events that result in flux in the system (Pickett, 2015). For example, the displacement of as many as 350,000 lower income residents by Haussmann’s creation of the grand boulevards of Paris (1854-1871), the relocation of African-American populations in order to construct New York’s Central Park (1857), the construction of the Ringstrasse (1865), to make way for more affluent residents of Vienna or Albert Speer’s plans for the redevelopment of Berlin (1938) are forms of disturbance. Similarly, the major highway building projects of Robert Moses in New York (Caro, 1974), the construction of Interstate 10 through the historically African-American neighborhoods along Claiborne Avenue in New Orleans in the early 1960s (Figure 50) and the construction of Interstate 70 through St. Louis in the late 1960s (Figure 21) are examples of *Homo sapiens* disturbance.



Figure 21: I-755 in St. Louis

Design initiatives such as Complete Streets and Safe Routes to School seek to minimize the disturbance effects and the barriers between ecological patches that major roadways often present (Landscape Architecture Foundation, 2016).

The wide variety of *Homo sapiens*-made management overlays, what Lyle called immaterial (non-physical) factors such as tax districts and jurisdictional boundaries, further fragment the environment (Lyle, 1985). The National Flood Insurance Program, a tool of *Homo sapiens* adaptation, is another management overlay that encourages development and rebuilding in flood-prone areas through the provision of federally subsidized insurance. Other *Homo sapiens*-made interventions, such as zoning, protective covenants, subdivision, financing, and insurance red-lining further divides the landscape into patches. These divisions are sometimes voluntary and at other times involuntary. The designation of a historic district from an ecological

perspective is an effort to reduce the dynamism of a patch of urban development and to eliminate or retard change within the patch. It is not known if the creation of these historic districts reduced parcel vacancy or if historic districts were created in already stable areas with little vacancy. If the former, the creation of historic districts could be a good management technique to stabilize and protect neighborhoods. Phases of land subdivision and urbanization, and in turn, the age of urban development create further fragmentation, since the functional obsolescence of infrastructure and buildings can create further distinguishing characteristics of the landscape.

Land ownership further fragments the landscape as individual land owners seek to maximize their economic value or utility, each making individual decisions and managing their properties in different ways. Land ownership patterns are enduring, particularly once legal restrictions such as zoning or protective covenants are put in place. These patterns typically outlive a long succession of buildings in an urban environment. Challenges in land assembly, as well as, financial and management limitations may impact the ability to undertake large development projects which also impacts patch size.



### 3.4 A HABITAT QUALITY MODEL FOR *HOMO SAPIENS*

How does the interplay of structure and agency determine which social groups occupy different patches within the contested landscape of the urban ecosystem? Can a framework be devised which explains the relationship between *Homo sapiens* and their habitat and in turn which patches support occupancy and which are prone to vacancy?

Habitat quality is defined as the resources and conditions present in an area that produces occupancy including survival and reproduction by a given organism (Hall, et al, 1997). Others have expanded this definition to include the concept of fitness. Fitness, often referred to as Darwinian fitness, is the genetic contribution of an individual to the next generation's gene pool relative to the average for the population, usually measured by the number of offspring or close kin that survive to reproductive age. Organisms that occupy habitats that maximize their lifetime reproductive success will contribute the most to future generations. Studies from a wide variety of species suggest that the prevalence and fitness of organisms in habitat patches and the connectivity between those patches all contribute to their ability to support population persistence.

If habitat quality is defined as areas that produce occupancy, areas of vacancy are areas of low habitat quality. If cities are in fact *Homo sapiens* habitat, it would stand to reason that a habitat quality model can be developed for *Homo sapiens* as they have for other species. If areas of high quality support occupancy, it would follow that areas of poor habitat quality would have less occupancy and thus higher vacancy. These areas of higher vacancy should contain higher quantities of publicly owned vacant land, and conversely areas of high habitat quality should have less vacancy and contain lower quantities of publicly owned vacant land.

Conservationists with limited resources must often prioritize areas to focus their efforts. To prioritize landscapes for conservation, ecologists have developed habitat quality models which can range from simple binary models (suitable versus marginal) to more sophisticated semi-quantitative habitat suitability indexes. At least

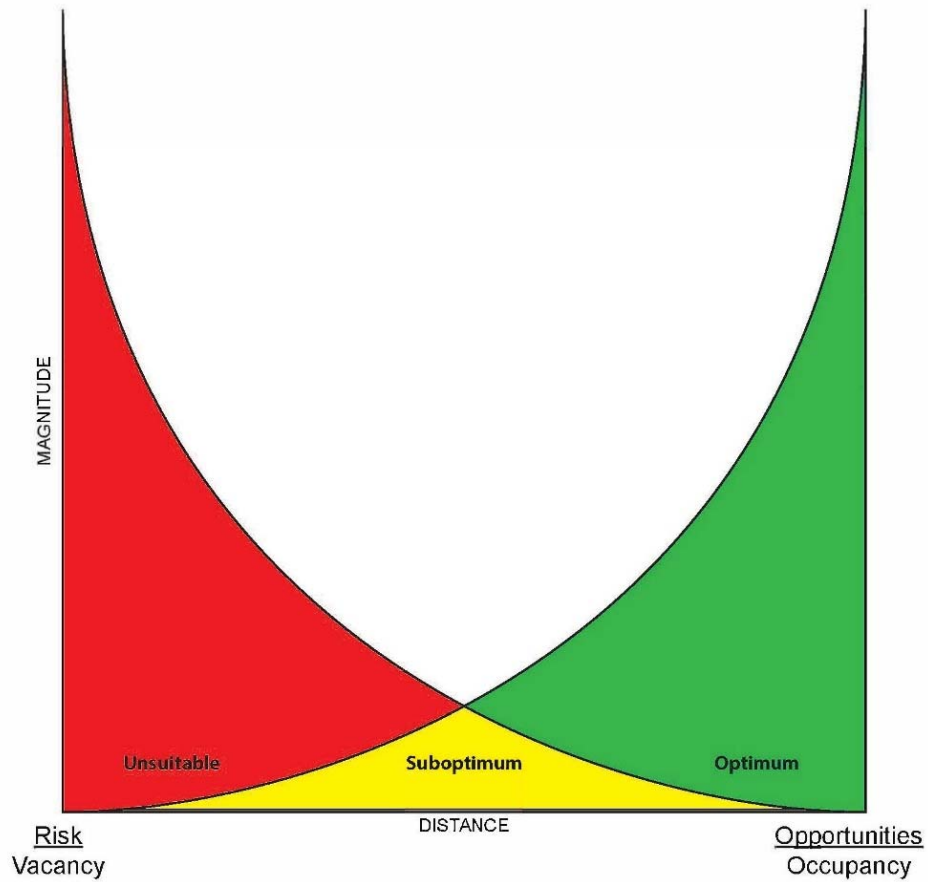
160 habitat suitability indexes, which rank habitat patches per a scale, exist for a variety of species. Although a variety of hedonic models have been created to examine different attributes of the urban environment, to date, no known comprehensive habitat quality model or habitat suitability index exists for *Homo sapiens*. Managers of shrinking cities who must determine how to invest the city's limited funds often prioritize portions of the city, or patches of habitat for investment, and must work without the benefit of a habitat quality model.

Animal use of an area varies in relation to cues in the landscape that signal the availability of food, shelter, or other resources favored by the species. This use often fluctuates seasonally and changes at different life-history stages. *Homo sapiens* often prefer different habitats at different stages of their life-history, with different desires and needs during their younger mating years, their years of child rearing, and their retirement days. Individuals or groups of individuals are drawn to food and suitable physical structures and avoid areas of lower quality. The term habitat, although often used loosely as an indication of environmental quality, refers to the combination of physical and biological features preferred by a species. Different habitat preferences reflect the evolution and adaptation of diverging species (Whittaker 1975).

Habitat preference is in part defined by availability of opportunities. *Homo sapiens* are known to show preferences for the quality and affordability of housing, proximity to employment, proximity of quality education, and proximity to parks and recreational opportunities. The presence of food deserts in major cities is one measure of poor habitat quality.

The relative absence of risk in the form of environmental stressors is another consideration of habitat quality. These stressors include geophysical features such as flooding, earthquakes, and soils subject to liquefaction. Technological stressors include the intrusion of major highways, railroad lines, and proximity to industrial lands. Pollution and other contaminants are environmental stressors in some habitat quality models and would logically apply to *Homo sapiens* as well.

Habitat quality is expressed in the following diagram. The greater the proximity to opportunities and the greater the distance from risk the higher the occupancy and the lower the vacancy. The greater the distance from opportunities and the greater the proximity to risks, the lower the occupancy and the higher the vacancy.



Habitat Quality and Land Vacancy

Figure 22: Habitat Quality and Vacancy for *Homo sapiens*

Sensory considerations are also a consideration in habitat selection for *Homo sapiens*. The absence of odors, loud noises, and the presence of views all influence habitat selection (Domigos and Anyfantis, 2011). The noise mapping contained within this thesis is an example of these sensory considerations.

A Habitat Quality Model for *Homo sapiens* was created by mapping opportunities and risks in their various forms. This model is specific to time and place and was developed for application to two shrinking cities in the United States, New Orleans and St. Louis. It is not suggested that this model is applicable to other societies such as feudal peasants or prehistoric clans, though it is hypothesized that such a model could be created for those societies. A variety of factors comprise opportunities for *Homo sapiens*, as well as, risks. Factors which contribute to opportunity and create risks for *Homo sapiens* were determined through the literature search. This framework is shown in the following diagram (Figure 23):

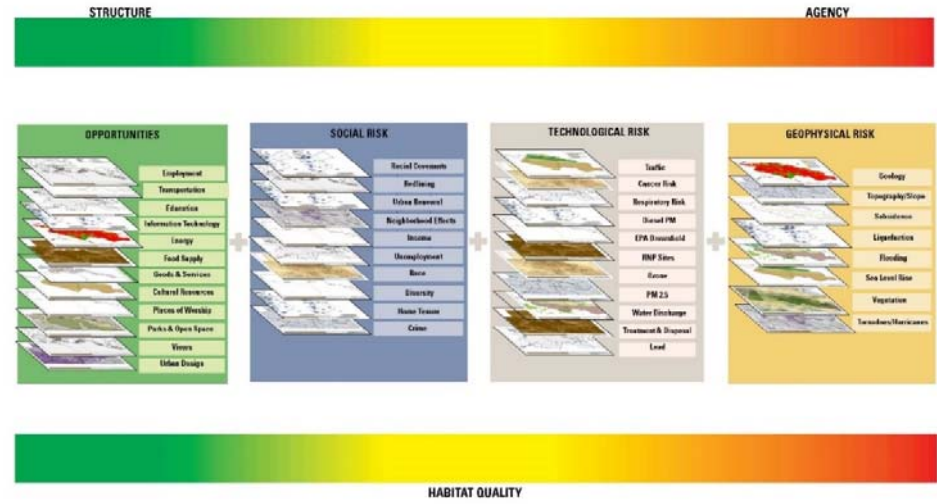


Figure 23: Habitat Quality Model

Access to opportunities and distance from risks is a product of both agency and structure and, as suggested by urban political ecologists, contested through the political process and power relationships.

### 3.4.1 Proximity to Opportunities

Habitat quality models typically consider opportunities (as a key indicator of habitat quality). Resources essential to *Homo sapiens* include employment or a source of income, education and information (which might include access to information technology), proximity to transportation, proximity to energy supplies, proximity to a food supply, and proximity to other goods and services. As social creatures, *Homo sapiens* also require other factors such as proximity to cultural resources (including entertainment), proximity to places of worship, proximity to parks and open space. Stimulation of the senses may also be a factor. In this regard, access to quality views may also be an indicator of quality habitat.

One might consider the opportunities maps created by the Kirwan Institute of Ohio State University as a partial habitat quality model in that it considers opportunities but only some of the risks found in a city. The Kirwan Institute has created Opportunities Maps for the 100 largest American Cities. These opportunity maps are derived from a set of indicators derived from literature, informed by local perspectives, and locally derived.

In New Orleans, these indicators include:

Education:

- Educational attainment for the total population
- School poverty for neighborhood schools
- Test scores for neighborhood schools
- Teacher qualifications for neighborhood schools (or certified teachers)
- Graduation rate or similar indicator for neighborhood schools

Environmental Health:

- Proximity to toxic waste release sites
- Measures for post-storm toxicity/mold
- Proximity to parks/open space

Public Health:

- Asthma rates (or proxy if local data is not available)

- Proximity to hospitals
- Per capita number of health professionals working in neighborhood
- Proximity to other health care facilities

#### Economic Opportunity and Mobility:

- Unemployment rates
- Population on public assistance
- Proximity to employment (job opportunities within 5 miles)
- Employment competition (ratio of jobs to labor force within 5 miles)
- Economic climate (change in number of jobs 1999 to 2004 within 5 miles)
- Economic climate (business creation from 1999 to 2004 within 5 miles)
- Mean commute time
- Employment diversity (number of well-paying opportunities by skill level)
- Public transit access

#### Infrastructure:

- Elevation/flood risk
- Transit access

#### Housing and Neighborhoods:

- Property values
- Housing vacancy rates
- Housing cost burden
- Crime rates
- Poverty rates
- Population change 1990-2000
- Home ownership

In St. Louis, the Kirwan Opportunity Mapping project considered three categories of factors: educational opportunity, environmental and health opportunity, and social and economic opportunity. Factors included are:

Educational Opportunity:

- Adult Educational Attainment
- Student (School) Poverty Rate
- Reading Proficiency Rate
- Math Proficiency Rate
- Early Childhood Education Neighborhood Participation Pattern
- High School Graduation Rate
- Proximity to High Quality Early Childhood Education Centers

Environmental and Health Opportunity:

- Retail Healthy Food Index
- Proximity to Toxic Waste Release Sites
- Volume of Nearby Toxic Release
- Proximity to Health Care Facilities
- Proximity to Parks and Open Space

Social and Economic Opportunity:

- Housing Vacancy Rates
- Foreclosure Rate
- Poverty Rate
- Unemployment Rate
- Public Assistance Rate
- Proximity to Employment

By understanding the influence of the availability of opportunities on publicly owned land vacancy, planners, landscape architects, architects, urban designers, and elected and appointed officials can begin to design a strategy for addressing the issue.

#### **3.4.1.1 Proximity to Employment**

A source of income is essential to the ability of *Homo sapiens* to meet their needs. For all but the fortunate few, this income comes through employment. Numerous studies demonstrate the relationship between residential property values and proximity to employment. Proximity to employment is used in pricing models for urban land and in hedonic models for residential home pricing (Ottensman, Payton, and Man, 2008). Song and others have found that population densities decrease with distance from employment centers (Song, 1994). Ottensman et al, found that a 10-minute increase in travel time to multiple employment centers resulted in decreases in residential sales prices of 9.1 to 12.9 percent. Proximity to employment was mapped utilizing data from the Quarterly Workforce Indicators of the United States Census. (*Quarterly Workforce Indicators 101*, 2017) and data from Policy Map of the Reinvestment Fund.

#### **3.4.1.2 Proximity to Transportation**

Related to proximity to employment is access to transportation. While a key use of transportation is for access to employment, transportation also plays a role in access to education, food sources, goods and services, and other amenities. Historically lower income populations, lacking means of transportation, settled near places of employment, such as factories, that brought with them a host of risks. Although industrial facilities are much cleaner than in the late 19<sup>th</sup> and early 20<sup>th</sup> century, proximity to industrial development still has negative impacts on quality of life and real estate values. While the advent of the automobile and the development of



public transportation systems has allowed greater flexibility in residential house choices, access to transportation remains an issue.

A study for the Center for Neighborhood Technology studied the relationship of residential property values and proximity to rapid transit. In Boston, residential property in the rapid transit area outperformed other properties in the region by 129 percent. In Chicago, public transit area home values performed 30 percent better than the region; in San Francisco, 37 percent; Minneapolis-St Paul, 48 percent; and in Phoenix, 37 percent (Center for Neighborhood Technology, 2013). This information was not available for New Orleans and St. Louis. Proximity to transportation facilities are thus a double-edged sword, adding value and improving habitat quality when they improve access and rapid transit and reducing value and habitat quality when the level of traffic and associated noise and pollution offsets and mobility benefits.

#### **3.4.1.3 Proximity to Education**

Measures of school quality is used in many hedonic models of real estate values. Research over the years has shown significant correlations between school quality and real estate values. Ottenman et al found that every 100-point decline in a school district's SAT score resulted in a 4.14 percent decline in residential sales prices. Access to data on school quality is difficult to obtain at a census tract level. Policy Map data is available for school enrollment, educational attainment, graduation rate, student-teacher ratios, student proficiency, school performance (point data), and the location of early learning centers and libraries.

#### **3.4.1.4 Access to Information Technology**

Access to information technology can be an important opportunity available to some but not all residents (Mapping the Digital Divide, 2017). In modern society, information is a nutrient to *Homo sapiens* habitat. The Connect-America project of the United States White House found that wealthier households are more likely to have access to the internet and the benefits that go with it at home. Measures of internet availability obtained from Policy Map was not found to be useful for defining habitat quality because data is not parsed by census tracts. Physical internet availability is ubiquitous in both New Orleans and St. Louis, but access is limited by income.

#### **3.4.1.5 Proximity to Energy**

The flow of energy must also be considered in the analysis. A study by the Brookings Institution found that a 10 percent increase in gasoline prices resulted in a 2.5 percent decline in real estate prices (Brookings, 2010). Similarly, electric, gas, and home fuel oil rates is shown to move residential real estate prices. Some cities, such as Chicago have passed ordinances requiring the disclosure of residential energy costs in home sales (Philbrick, Scheu, and Blaser, 2016).

An analysis of energy flows would include an understanding of natural gas pipelines and high voltage electrical transmission lines. The siting of power plants (coal, electrical, nuclear) is another consideration in assessing habitat quality. Several researchers have examined the impact of power plants on residential property values (Bezdek and Wendling, 2006 and Davis, 2010). Though Bezdek and Wendling did not find a statistically significant correlation between nuclear powerplant proximity and residential real estate prices, Davis found a 3-7 percent decrease in values within two miles of power plants. The ESRI data atlas contains GIS shapefiles on nuclear and coal-fired power plants. Mapsearch provides a North American Power GIS database of the electrical power infrastructure on the continent.

#### **3.4.1.6 Proximity to Food Supply**

The United States Department of Agriculture defines food deserts as areas void of fresh fruit, vegetables, and other healthful whole foods, usually found in impoverished areas. This is largely due to a lack of grocery stores, farmers' markets, and healthy food providers (American Nutrition Association, 2017). A census tract is considered a food desert if it has low income and low access to healthy, affordable food. A census tract qualifies as a food desert if the nearest supermarket or grocery store is one mile in urban areas and 10 miles in rural areas. The United States Department of Agriculture states that if 33% of the population or 500 people are outside of this range, the area qualifies as a food desert. An area is considered low income "if the poverty level is 20% or the median household income not more than 80% of the statewide or metropolitan area median household income. (Food Desert, 2017).

In assessing the health of various species, ecologists study the health of the food web, the entirety of interrelated food chains in each community. Research suggests that low income communities, communities of color, and sparsely populated rural areas lack access to opportunities to buy quality, affordable food and can suffer from diet-related diseases like diabetes and obesity (PolicyLink, 2010). Food deserts are an indicator of weakness on the food web for *Homo sapiens* and in turn, poor quality habitat. Data from ESRI maps grocery stores in New Orleans (Food Desert, 2017). The Department of Health of the City of St. Louis has mapped food deserts in that city. The United States Department of Agriculture (USDA) ESRI Food Desert Locator program was also consulted for information (Food Access Research Atlas, 2017). The Kirwan Institute opportunity maps of New Orleans and St. Louis also factor access to food resources into their analysis.

#### **3.4.1.7 Proximity to Goods and Services**

In addition, access to groceries and other food sources, and proximity to other goods and services are also considerations in residential home values. The geographic information system databases of the City of New Orleans and City of St. Louis contain shapefiles of existing retail land uses and retail zoning. No attempt was made to evaluate the features which may influence land vacancy such as the composition of desired goods and services or minimum patch size of retail land uses or the distance effect. The ESRI Business Analyst toolbox allows for the generation of trade areas (An Overview of the Trade Area Toolset, 2017).

#### **3.4.1.8 Proximity to Cultural Resources and Places of Worship**

As social creatures, *Homo sapiens* seek interactions with other *Homo sapiens*. Researchers have demonstrated the value of the arts, music, and of entertainment venues like sports teams (Shephard, Oehler, and Benjamin, 2013). Others have researched the benefits of cultural diversity, historic preservation, and the enhancement of other cultural benefits as well (Florida, 2002). The cultural resource database of the United States National Park Service provides GIS

information on the location of prehistoric and historical resources. Although places of worship may exhibit a distance effect on land vacancy, this effect is not examined due to limited resources.

The value of proximity to places of workshop and residential home values has not been studied in detail and conclusions are mixed (Carroll, et al, 1996). The traffic and congestion generated by extremely large churches appears to offset the social and spiritual benefits of having a place of workshop near one's home. The United States Department of Homeland Security created a GIS database of places of worship within the United States. Although places of worship may exhibit a distance effect on land vacancy, this effect was not examined due to limited resources.

#### **3.4.1.9 Proximity to Parks and Open Space**

Numerous studies have demonstrated the correlation between real estate prices and proximity to open space. (Anderson, 2001). Quang Do and Grudnitski found that homes adjacent to golf courses increases the home values by as much as 7.6 percent (Quang Do and Grudnitski, 1995). Weicher and Zerbst found that homes adjacent to neighborhood parks may increase residential property values as much as 23 percent (Weicher and Zerbst, 1973).

Correll found that residential property values decreased by as much as 8.5 percent per 1000 feet of walking distance to parks (Correll, et al, 1978). The variety and quality of parks and open space within a city make uniform treatment of open space within a city difficult, but the positive correlations are nonetheless well documented. The City of New Orleans and City of St. Louis geographic information system databases both contain shapefiles of parks within the city. The Kirwan Institute incorporated distance to parks within their Opportunity Mapping of New Orleans and St. Louis. The ParkScore initiative of the Trust for Public Land classifies urban environments by their relative level of park need.

#### **3.4.1.10 Proximity to Views**

When assessing the nature of *Homo sapiens* and their preferences for habitat, one may ponder whether *Homo sapiens* are an edge or core species. Edge species are those that prefer to live at the edge of a habitat such as a forest. Some

species are far more sensitive to the edge condition and depend upon access to the core of a given habitat for survival. While determination of whether *Homo sapiens* are a core or edge species is beyond the limits of this study, numerous studies have demonstrated the correlation between real estate prices and views (Yu, Han, Chai, 2007). Similarly, the value of adjacency to coastlines, mountains, and water has been documented (Hansen, J. and Bensen, E., 2013). Due to limited resources, views were not included in the Habitat Quality Model.

#### **3.4.1.11 The Value of Urban Design**

The efficacy and agency of design has long been debated (Kaminer, 2017). Architects, landscape architects, and planners have long contended that design and aesthetics can shape the quality of urban life. Research reviewed supported this assertion (Eppli and Tu, 1999; The Bartlett School of Planning, 2001; Jenckes, 2008). Though, the measurement of the influence of urban design on land vacancy in New Orleans and St. Louis was beyond the limits of this study, design quality should be a consideration in the development of a habitat quality model for *Homo sapiens*.

#### **3.4.2 Geophysical Risk and Vulnerability**

Opportunities are an important consideration in habitat preferences. But the absence or minimization of risk is also a consideration in most habitat quality models. What environmental stressors impact habitat selection in *Homo sapiens*? The concept of vulnerability has evolved from disciplines focused on disaster relief, but these concepts can easily be applied to habitat under normal circumstances. Physical threats may be thought of as risks such as flooding, earthquakes, fires, hurricanes, and tornadoes. These types of risks are geophysical risks. Threats from the natural environment as also referred to as natural risks. The disproportionate exposure of some populations to geophysical risks raises questions of environmental justice, and as urban planner Edward Soja suggests, the need for spatial justice (Soja, 2010). Populations subject to such risks are often subject to death and illness,

but also loss of income due to the disruption or destruction of business enterprises, but also to loss of net worth due to the damage or destruction of property. Such impacts further increase their vulnerability to future hazards.

#### **3.4.2.1 Soils and Geology**

Soils maps for the site of New Orleans and St. Louis are available from the United States Department of Agriculture and were mapped as part of this effort. Soils in some portion of St. Louis are subject to collapse. Collapsible soils are those unsaturated soils that can withstand relatively high pressure without showing significant change in volume. Upon wetting, they are susceptible to a large and sudden reduction in volume. Collapsible soils can have extremely expensive impacts on construction. The location of collapsible soils was mapped utilizing data available for the Missouri Department of Natural Resources.

#### **3.4.2.2 Topography & Slope**

One-meter digital elevation model data was available for both New Orleans and St. Louis and digital terrain models created for both as part of this research. The site of New Orleans is virtually flat and offers no slope constraints to development. The site of St. Louis does contain topographic relief though the city was significantly shaped by earthwork during its construction. Some areas of landslide potential still exist within the city and were mapped utilizing data available from the Missouri Department of Natural Resources.

#### **3.4.2.3 Subsidence**

Researchers at the Jet Propulsion Laboratory have studied subsidence in New Orleans and provided data for use in this research. The causes of this subsidence are

varied and difficult to pinpoint. Researchers at the Jet Propulsion Laboratory theorize that subsidence is caused by the decay and compaction of the organic soils of former swamp and marshlands, and by the pumping of groundwater for industrial use in the city. Subsidence is not known to be a problem in St. Louis.

#### **3.4.2.4 Liquefaction**

Given the proximity of St. Louis to the New Madrid Fault and risk of earthquakes, liquefaction is a risk to residents of the city. The New Madrid Seismic Zone is the most active seismic zone in the United States. It is located in southeastern Missouri, northeastern Arkansas, western Tennessee, western Kentucky, and southern Illinois. Soil liquefaction is a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking, causing it to behave like a liquid. The Missouri Department of Natural Resources mapped areas of the state that are subject to liquefaction. Liquefaction is not known to be a risk in New Orleans.

#### **3.4.2.5 Flooding**

The Federal Emergency Management Agency (FEMA) generates floodplain maps for the United States. FEMA maps of the 100-year and 500-year flood were utilized for this research.

#### **3.4.2.6 Sea Level Rise**

There is a great deal of political debate about the impacts of sea level rise in the United States. The National Oceanic and Astronomical Administration (NOAA) has studied the potential impact of New Orleans based upon a sea level rise of three feet and

six feet. For this research, a sea level rise of three feet was considered in New Orleans. St. Louis is not anticipated to be impacted by sea level rise.

#### **3.4.2.7 Vegetation**

Vegetation was a resource to early settlers of New Orleans and St. Louis as a source of fuel and building materials and as a commercial product. Vegetation also provided habitat for the wildlife that was a source of food for earlier settlers as well. New Orleans and St. Louis have long been anthropomorphic landscapes modified by the native Americans who occupied the original sites of both cities (Mann, 2005). Although forest cover existed along stream corridors and the floodplain of the Mississippi and Missouri Rivers, the site of St. Louis was largely prairie prior to European settlement. Native Americans were known to burn forests to create grasslands for wildlife and to facilitate hunting. Whether these prairies were naturally occurring or created due to such burning is unknown. The Missouri Department of Natural Resources has mapped pre-settlement prairies. This data layer utilized in this research.

The pre-settlement vegetation cover of the site of New Orleans was estimated by digitizing historic maps of the site of the city. Prairies, marshes, and hardwood forests were known to have existed on the city of the current city of New Orleans. In addition, canebrakes, dense growing plants which were virtually impenetrable by early explorers. A brake is a rough or damp area overgrown with one kind of plant. Taller canebrakes most commonly consisted of giant, or river, cane (*Arundinaria gigantea* ssp. *gigantea*). Canebrakes are no longer found along the branches of the Mississippi or other rivers in the region.

In both New Orleans and St. Louis, the fact that no old growth forest remains suggests that vegetation is ephemeral with little lasting impact on the form and character of a city. However, recent research demonstrated the relationship of tree canopy and property values (Dimke, 2008). Although the current tree canopy of New



Orleans and St. Louis likely influences habitat quality, the influence of current vegetation was not considered in this research.

#### **3.4.2.8 Tornadoes and Hurricanes**

New Orleans and St. Louis have been home to some of the worst natural disasters in United States history. However, at present there is no known way to model the potential impacts of future tornadoes and hurricanes at a census tract level. Storm surge, which represent a significant risk during hurricanes like Katrina, were considered for this research to be reflected in measurements of sea level rise.

There are two other forms of geophysical risks. These are technological risk – risks resulting from proximity to industrial lands (or other noxious uses) and proximity to major forms of infrastructure such as major highways or rail lines. Technological risks, as evidenced in the aftermath of Hurricane Katrina in New Orleans, can be amplified by factors in the natural environment to form a second form of risk: Natech risks. Natech risks are industrial disasters triggered by natural disasters (Krausmann, 2017).

#### **3.4.3 Social Risk and Vulnerability**

Cutter (1996) distinguished vulnerability into three distinct clusters: risk of exposure to hazards, capability for response, and attribute of place. The capability for response and attribute of place address the resilience of the community, but there are other kinds of risk including crime, poor education, and other challenges to health. These types of threats are social risks. The Center for Disease Control published a Social Vulnerability Index which identifies the demographic factors that increase the social burdens of risk: how those factors affect the distribution of risk and losses. The Social Vulnerability Index groups factors into four categories, Social Economic (below

poverty, unemployed, income, and no high school diploma), Household Composition and Disability (age 65 or older, age 17 or younger, older than 5 with a disability, single-parent households), Minority Status and Language (minority, speak English “less than well,”) and Housing and Transportation (multi-unit structures, mobile homes, crowding, no vehicles, and group quarters). Social vulnerability refers to the inability of people, organizations, and societies to withstand adverse impacts from multiple risks to which they are exposed. These impacts are due in part to characteristics inherent in social interactions, institutions, and systems of cultural values.

All species compete for limited resources and habitat. Social hierarchy is a survival strategy selected by most if not all primates including *Homo sapiens*. Sidanius and Pratto suggested that social dominance in a society is necessary for survival and provides structure to a society (Sidanius, 1999).

Decisions about scarce resources, including habitat, can be based on a social dominance perspective (Houser, 2004). Persistent social dominance by a group can result in internalized oppression. Despite tremendous effort and what appears to be our best efforts stretching over hundreds of years, discrimination, oppression, brutality, and tyranny remain all too common features of the *Homo sapiens* condition (Sidanius, 1999). This oppression can take the form of racism and in turn find its way into management decisions intended to isolate some groups and benefit others.

#### **3.4.3.1 Race and Vacancy**

The racial composition of a neighborhood can also reflect segregation. The relationship of race and property values have also been studied. The Metz study of the relationship between race and real estate values in St. Louis suggests that property values may go up or down based upon who moves into the neighborhood (Metz, 2016). The median net worth of an African-American family in the United States is one-tenth of that of white families, impacting their ability to buy homes in safer neighborhoods, provide education for children, and withstand hardships.

#### **3.4.3.2 The Diversity Index**

The Theil index is a statistic primarily used to measure economic inequality and other economic phenomena, though it has also been used to measure racial segregation. It is theorized that a lack of diversity leads to patch instability.

#### **3.4.3.3 Racial Covenant**

Racial deed restrictions became common after 1926 when the U.S. Supreme Court validated their use. The restrictions were an enforceable contract and an owner who violated them risked forfeiting the property. Many neighborhoods prohibited the sale or rental of property by Asian Americans, African-Americans, and Jews. In 1948, the court reversed its earlier opinion, declaring that racial restrictions would no longer be enforced, but the decision did nothing to alter the other structures of segregation. It remained perfectly legal for realtors and property owners to discriminate based on race. In 1968, Congress passed the Fair Housing Act, finally outlawing discrimination based on race or ethnicity in the sale or rental of housing. Racial deed restrictions were used extensively in both New Orleans and St. Louis.

#### **3.4.3.4 Redlining**

Redlining is the practice of denying services (a loan or insurance) to someone because they live in an area deemed to be a poor financial risk. In the United States in the 1930s, the government-sponsored Home Owners Loan Corporation drafted maps to determine which neighborhood were worthy of mortgage lending. Neighborhoods were ranked and color-coded. Green areas were considered first class or best. Blue areas second class or still desirable. Yellow areas were third class or declining and red areas were fourth class or hazardous. Private banks quickly adopted the practice of redlining, thereby

denying many neighborhoods, particularly those of African Americans an essential nutrient flow of capital. Though the Fair Housing Act of 1968 outlined the practice, some have argued that the practice persists today in subtler forms (Badger, 2015). Many of these influences are endogenous, originating within the communities of New Orleans and St. Louis.

Redlining has been found to have persistent effects in Pittsburgh and other cities. Residential patterns in Pittsburgh are today virtually unchanged from their established in the 1930s. Yellow and red areas as displayed on redlining maps from the period are still the poorest areas of the city and contain the highest concentrations of people of color, illustrating the ability of management actions like redlining to produce persistence of poverty within a city (Rutan, 2016).

#### **3.4.3.5 Urban Renewal**

Following World War II, and continuing into the early 1970s, urban renewal referred primarily to public efforts to revitalize aging inner cities. Including massive demolition, slum clearance, and rehabilitation, urban renewal proceeded initially from local and state legislation. The earliest emphasis was placed on slum clearance or redevelopment which was followed by a focused effort to conserve threatened but not yet deteriorated neighborhoods.

The new legislation had three primary functions. First, it expanded the city's power of eminent domain and enabled it to seize property for the public purpose of slum clearance or prevention. Second, it pioneered the write-down formula which permitted the cities to convey such property to private developers at its greatly reduced use value after the municipality subsidized its purchase and preparation. Last, the state aided in relocating site residents to enable the clearance of crowded, inner-city sites. The federal Housing Acts of 1949 and 1954, and their later amendments, provided a national framework and greater financial resources for the renewal effort (City Plan Commission of St. Louis, 2009).

Demolition in New Orleans was primarily focused on the Claiborne Avenue corridor and the construction of Interstate 10 through primarily African-American neighborhoods. Demolition in St. Louis was much more aggressive and was focused on the Mill Creek corridor and the Near Northside. This demolition constituted a significant manmade disturbance and publicly owned land vacancy from these actions largely remains.

#### **3.4.3.6 Public Housing Projects**

Throughout the country, cities built publicly- funded housing projects for those who were unable to find affordable housing opportunities in the private sector. By the mid-1930s the government began to lure white families out of public housing with federally-insured mortgages that subsidized relocation to new single-family homes in the suburbs. With Federal Housing Administration (FHA) and then, after World War II, Veterans Administration (VA) guarantees, white middle-class families could buy suburban homes with little or no down payments and extended 30-year amortization schedules. Monthly charges were often less than rents the families had previously paid to housing authorities or private landlords (Rothstein, 2012).

Although the Supreme Court ruled in 1948 that racial restrictions were legally unenforceable, the FHA and VA continued to insure such mortgages. By 1950, the federal agencies were insuring half of all new mortgages nationwide. The government had an explicit policy of not insuring suburban mortgages for African Americans. As a result, the movement of whites to the suburbs was facilitated while African-Americans movement from the inner city was restricted. The inner city over time became increasing African-American and public housing projects over time became concentrated patches of poverty and racial minorities. The most infamous of these was the Pruitt-Igoe development, a 74-acre sites on the north side of St. Louis. New Orleans built a dozen similar public housing projects such as Lafitte, Iberville, and Desire Street. Some projects, like Pruitt-Igoe in St. Louis have been demolished contributing

to the supply of publicly owned vacant land. These housing projects are a type of habitat patch and proximity to these areas of poverty may also have an impact on the desirability of surrounding properties as well.

#### **3.4.3.7 Neighborhood Effects**

The neighborhood effect is an ecological, economic, and social science concept that posits that neighborhoods have either a direct or indirect effect on individual behaviors and public health outcomes. Neighborhood effects can represent a form of social risk. When examining the stability or health of patches, one must consider the endogenous neighborhood effects as well as the impact of exogenous disturbances. From a patch dynamics perspective, neighborhood effects consider impacts on populations due to conditions within a given patch rather than external to the patch. In an urban condition, efforts to reduce crime, increase nutrition, or improve education are examples of management efforts to improve conditions within the patch. But neighborhoods effects can also be positive. Research suggests that when a high level of social capital is present, neighborhoods have proven to be very resilient.

Neighborhood effects can also create vacancy in adjacent lands that are otherwise high-quality habitat. The Broken Windows Theory (Wilson, Kelling, 1982) posits that broken windows are a metaphor for disorder within community. The theory links disorder and incivility within a community to subsequent serious crime. Wallace and Wallace (1990) also demonstrated that urban decay can be contagious. This may help to explain in part why some vacant land in New Orleans and St. Louis is found in areas of the city that are otherwise optimum habitat.

Real estate research similarly focuses on neighborhood characteristics and their impacts of real estate prices. Chang and Lin found that home buyers in Taipei prioritize the environment and public facilities and services before considering individual houses (Chang, L., and Lin, H-Y., 2012). Neighborhood characteristics

often examined in such studies include crime rates, the socio-economic status of the neighborhood, and racial composition.

#### **3.4.3.8 Median Household Income and Vacancy**

One measure of neighborhood effects is the relative disparity between the wealthy and the poor within a city. The GINI index is a measure of the income distribution of a population's residents. This number, which ranges between 0 and 1 is based on net income, helps define the gap between the rich and the poor, with 0 representing perfect equality and 1 (or 100) representing perfect inequality. New Orleans, with a GINI index of .5744, trails only Atlanta (.5882) with the highest GINI coefficients among all American cities. The national GINI coefficient is .4757. In New Orleans, the bottom 40 percent of the population earns just 7.5 percent of the income. Inequality in New Orleans is growing rapidly. New Orleans' GINI coefficient rose 5.39 percent since 2008. Only 14 of the 50 largest United States cities saw inequality grow faster than in New Orleans (NOLA, 2015). St. Louis has a GINI index of 0.52.

#### **3.4.3.9 Unemployment and Vacancy**

Unemployment is an absence of opportunity and access to the flow of financial resources. The absence of income can in turn lead to instability of housing opportunities and access to other opportunities such as quality education. Unemployment rates are also highly related to crime and other social ills. (Branch, W., Petrosky-Nadeau, N, and Rocheteau, G., 2014).

#### **3.4.3.10 Home Tenure and Vacancy**

While there is nothing to suggest that renters are second class citizens or that policies to promote sound rental practices are not important to the health of the urban ecosystem, home tenure can also be a reflection of neighborhood stability. Research has shown that the higher the homeownership rate, the better properties are maintained and the better their condition. Higher home ownership rates are also associated with higher incomes and higher property values. Areas of high home ownership also tend to have lower rates of tax delinquency. Higher home ownership rates have also been found to be positively correlated with lower dropout rates, lower juvenile delinquency rates, lower teen pregnancy rates, and higher levels of educational attainment. Other research has suggested that higher levels of home ownership are also associated with high level of social capital and collective efficacy. With a decline in homeownership rates comes a decline in neighborhood stability. Data on the percentages of renters and owners by census block was obtained from PolicyMap.

#### **3.4.3.11 Crime and Vacancy**

Numerous studies have examined the relationship between crime and residential property values. If habitat quality is a measure of the ability for a habitat to support population persistence, then crime, which impacts mortality rates, is certainly a consideration in determining habitat quality. (Rizzo, M. 1979).

Crime data is available from the national crime index from ESRI online. Data on a census tracts are classified by the percentage of the national average crime rate. For example, a crime index of 0-25% suggests that crime in the census tract is approximately 25% of the national average. Policy Map provided city-wide statistics on aggravated assault, murder, rape, robbery, burglary, and motor vehicle theft, but this information was not parsed by census tract and thus not of value in this analysis.

#### **3.4.4 Technological Risks**



In addition to geophysical and social risks, proximity to noxious land uses can also reduce habitat quality. A key source of data for technological risk is the United States Environmental Protection Agency EJ Screen mapping tool. EJSCREEN is an environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach for combining environmental and demographic indicators. The Environmental Protection Agency defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. EJ Screen can be utilized to generate maps for eleven factors including National Scale Air Toxics Assessment Air Toxics Cancer Risk, National Scale Air Toxics Assessment Respiratory Hazard Index, National Scale Air Toxics Assessment Diesel PM (DPM), Particulate Matter (PM2.5), Ozone, Lead Paint Indicator, Traffic Proximity and Volume, Proximity to Risk Management Plan Sites, Proximity to Treatment Storage and Disposal Facilities, Proximity to National Priorities List Sites, Proximity to Major Direct Water Dischargers.

Impacts are expressed in terms of national averages. The national percentile indicates what percent of the US population has an equal or lower value, meaning less potential for exposure/ risk/ proximity to certain facilities, or a lower percent minority.

#### **3.4.4.1 Proximity to Traffic**

Studies have shown that airplane traffic has the most negative impact on property values, followed by automobile traffic and railroad traffic (de Vor, de Groot, 2010). Research has shown a one percent reduction in residential property values for each 1,000 ADT increase in average daily traffic (ADT). The EPA EJ Screen maps proximity to traffic in the United States.

Roadways provide access to property but the safety, congestion, and noise can have detrimental impacts. The National Transportation Noise Map maps aviation and road noise levels in the United States (USDOT, 2017). In 2018, the

Department of Transportation will add railroad noise to this database enhancing the understanding of risk from proximity to railroads.

#### **3.4.4.2 Proximity to Railroads**

Several studies have shown the impact of proximity to railroads on residential property values. Research in Oslo, Norway, suggested a 7-10 percent reduction of home values within 100 (328 feet) meters of a railroad track.

#### **3.4.4.3 Proximity to Industrial Areas**

Industrial sites bring multiple externalities including truck traffic, congestion, obstruction of views, and at times pollution, and odor. Studies have shown that proximity to industrial sites negatively impact residential real estate values (de Vor, de Groot, 2010).

Dutch researchers found that these impacts decreased with distance but still extended 2,250 meters (8550 feet) from the site. Homes within 250 meters of an industrial site were found to sell for 14.9 percent less than homes farther than 2,250 meters from the industrial area.

#### **3.4.4.4 Proximity to Pipelines and High Voltage Transmission Lines**

Several researchers have examined the influence of high voltage transmission lines on residential property values (Pitts and Jackson, 2007; Jackson and Pitts, 2010). Proximity to high voltage powerlines was shown to have no significantly valid impact on real estate values. A GIS database of powerline locations is available from the Homeland Infrastructure Foundation but high voltage transmission lines were not included in the Habitat Quality Model because the data was not sufficiently detailed.

Similarly, several researchers have examined the relationship between natural gas pipelines and residential property values and found no statistically significant correlation (Fruits, 2008, and Disken, et al, 2011). A GIS database of the North American Energy Industrial Complex is available from ESRI, however, because of the lack of correlation, natural gas pipelines were not included in the Habitat Quality Model.

#### **3.4.4.5 Proximity to Landfills and Waste Incinerators**

Several researchers have studied the relationship between landfills, waste incinerators, and residential real estate values (Faber, 1998, and Braden, et al, 2010). A GIS database of these sites was available from the Environmental Protection Agency (FRS Data Sources, 2017). It was the introduction of waste incinerators into low income minority neighborhoods of Houston that led Robert Bullard to found the environmental justice movement.

#### **3.4.4.6 Proximity to Cancer Risk**

Cancer risk as recorded by EJScreen indicates lifetime cancer risk from inhalation of air toxics, and as expressed as risk per lifetime per million people.

#### **3.4.4.7 Proximity to Respiratory Risk**

The air toxics respiratory hazard index of EJScreen indicates the sum of hazard indices for those air toxics with reference concentrations based on respiratory endpoints, where each hazard index is the ratio of exposure concentration in the air to the health-based reference concentration set by EPA. A database of this pollution is available on EPA EJScreen.

#### **3.4.4.8 Exposure to PM 2.5**

PM (Particular Matter) 2.5 is another form of air pollution. Although industrial operations can contribute to PM 2.5 pollution, dust stirred up from roads is another source. PM 2.5 particles are 2.5 micrometers in size or smaller and can only be seen with an electron microscope (EPA, 2017). A database of this pollution is available on the EPA EJScreen.

#### **3.4.4.9 Proximity to Diesel PM Risk**

Another form of air pollution is diesel emissions. As recorded by EJScreen, the diesel particulate matter level in air is indicated in micrograms per cubic meter.

#### **3.2.1.1 Exposure to Ozone**

Major highways can contribute to ozone pollution. Ground level ozone is an irritant that damages lung tissue, aggravates heart and respiratory disease and can contribute to mortality. Ozone is particularly a problem in St. Louis where higher temperatures cause the ozone to react with vehicle emissions and create smog. As areas of high vacancy are impacted by proximity to traffic it follows that they would also be areas which experience high ozone pollution as well (Figure 89). A database of these sites is available on the EPA EJScreen.

#### **3.4.4.10 Proximity to EPA Brownfield Sites**

The Environmental Protection Agency defines a brownfield as a “real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.” Wright and Davlin (Bowman and Pagano, 2004) classify brownfields into three groups based on their contamination levels and market potential: 1) sites that pose some contamination issues but are economically viable development projects; 2) sites that have either higher contamination or are less marketable; and 3) sites that are least likely to be redeveloped, posing high environmental risks, and if

remediated possess negligible economic potential. The Environmental Protection Agency labels brownfield sites that are particularly contaminated as Superfund sites. A Superfund site is any land in the United States that has been contaminated by hazards within 100 (328 feet) meters of a railroad track waste and identified by the Environmental Protection Agency as a candidate for cleanup because it poses a risk to *Homo sapiens* health and/or the environment. These sites are placed on the National Priorities List (NPL). A GIS database of these sites is available on the EPA EJ Screen.

#### **3.4.4.11 Proximity to EPA RMP Sites**

The Environmental Protection Agency classifies Risk Management Plan (RMP) sites as those with potential for the release of hazardous substances into the air. As with brownfield sites, the proximity to these potential hazards is highly related to land vacancy. A database of these sites is available on the EPA EJScreen.

#### **3.3.4.12 Proximity to Water Discharge**

Wastewater discharges from industrial and commercial sources may contain pollutants at levels that could affect the quality of receiving waters or interfere with publicly owned treatment works (POTWs) that receive those discharges. The National Pollution Discharge Elimination System (NPDES) permitting program establishes discharge limits and conditions for industrial and commercial sources with specific limitations based on the type of facility/activity generating the discharge. Proximity to these discharge sites may impact habitat quality. A database of these sites is available on the EPA EJScreen.

#### **3.3.4.13 Proximity to Treatment Storage and Disposal Facilities**

The Environmental Protection Agency also requires permitting, inspection, and monitoring of hazardous waste treatment, storage, and disposal facilities.

Proximity to these facilities may impact habitat quality. A database of these sites is available on the EPA EJScreen.

#### **3.3.4.14 Proximity to Lead**

Much of the urban area of New Orleans and St. Louis is contaminated with lead. Lead paint and dust is found in older homes that were painted with lead based paint before it was banned for consumer use. Lead-contaminated soil is found in yards and playgrounds. The use of lead as an additive for gasoline resulted in the concentration of lead around major highways. As the public becomes more aware of the dangers of lead, maps have been generated to illustrate lead concentrations in New Orleans (Tulane, 2017).

#### **3.3.4.15 Natech Risks:**

In his study of the Inner-harbor Navigation Canal (Industrial Canal) in New Orleans, researcher Jerry Graves argued that the environmental risk of infrastructure projects can be magnified when exposed on vulnerable populations and may result in displacement and disinvestment. Graves calls such hazards Natech (nature and technology) risks. These risks can have impacts at a micro (individual and household) and macro level (neighborhood). These hazards can create a pattern of increased risk that increases vulnerability to subsequent hazard events over time. Graves further argues that the parallels between the causes and consequences of traditional environmental justice issues and exacerbation of exposure to hazards can best be communicated as a justice issue. With a proliferation of industrial development within the floodplain of the Mississippi River, St. Louis is also susceptible to natech risks.

### **3.2.2 Real Estate Values as an Indicator of Habitat Quality**

British real estate tycoon, Sir Lord Harold Samuel is credited with creating the aphorism, “location, location, location.” The term first appeared in print in a 1926 real estate ad in the *Chicago Tribune* (Safire, 2009).

A mantra for real estate brokers, the term suggest that the price of a comparable home is affected by its location. One might modify a structure, remodel it, or change it layout but you cannot change its location. Real estate brokers consider many of the same issues that are represented in the habitat quality model utilized in this research including proximity (opportunities) to top-rated schools, proximity to recreation and nature, scenic views, proximity to entertainment and shopping, economically stable neighborhoods, public transportation, health care, and jobs. In addition, most homebuyers look for conforming areas (neighbors will similar values and similar types of property). Buyers prefer the center of a block versus corner properties. Undesirable locations (risk) include commercial/industrial areas, transportation impacts including railroad tracks, freeways, and under flight paths, high crime areas, economically depressed areas, and close to hazards such as pollution and flood prone areas. The habitat quality model thus links together ecology and economics, two words both derived from oikos, the Greek word for family or household.

Real estate prices reflect consumer preferences. Real estate prices have been shown to correlate with a variety of factors including location, size and quality of property, convenience, environmental quality, views, workplace accessibility, developer reputation, and promotional efforts. Research suggests that these factors are implicitly included in real estate prices. Such research in turn suggests that real estate prices may be one indicator of habitat quality.

There is also a variety of research efforts that identify the relationship between land values and different types of risks – spatial and social. Studies include an investigation of the impact of flood risk in England (Bhattacharya, N., 2015) and sea level rise in North Carolina (Whitehead, 2011). Seth Knutsen, project manager with the New Orleans Redevelopment Authority (NORA) indicated that NORA has found that when lot prices are below \$15,000 per lot they tend not to redevelop once sold. Lots that sell for \$15,000 or more tend to be redeveloped. This inverse relationship between land values and land vacancy is quite strong. Research suggests

that the market may have already intrinsically factored opportunities, as well as spatial and social risk in determining land values. If, for example, an area of New Orleans is known to have a high level of geophysical risk such as being prone to flooding or subsidence, or high social risk such as high crime rates or poor public education, land values tend to be lower than in areas of the city where such conditions do not exist. Crime can be reduced and public education improved, but the geophysical risk is not as easily mitigated. Certainly, the attractiveness of a property can also influence land values including the age and condition of structures or proximity to amenities such as parks as well. The idea that opportunities and distance from risk determines habitat quality, is another way of stating the old real estate maxim of “location, location, location.”

#### **3.4.5.1 Market Value Analysis of the Reinvestment Fund**

Real estate values can be extracted from parish assessed valuation data in New Orleans and from county assessed valuation data in St. Louis. However, the Reinvestment Fund has completed market value analysis for both New Orleans and St. Louis. The market value analysis is a data- based tool to inform community revitalization and manage neighborhood change. Although market value analyses vary somewhat from city to city, the following indicators are often used: median and variability of housing sale prices, housing and land vacancy, mortgage foreclosures as a percent of units (for sales), rate of owner occupancy, presence of commercial land uses, share of the rental stock that receives a subsidy, and density. Data is analyzed as a block group level. This data allowed the comparison of land vacancy and real estate values(Goldstein, 2012).

### **3.6 CONCLUDING REMARKS**

A review of existing literature offers few studies which consider *Homo sapiens* as part of nature rather than separate from nature. There are also few examples of research which consider the relationship of *Homo sapiens* and their environment from a biological perspective, though a review of ecological theory and ecological structure suggest that this framework may reasonably apply to *Homo sapiens*. Nor are there known examples of a comprehensive habitat quality



model for *Homo sapiens*, though many exist for other species. There are, however, numerous examples of studies, such as hedonic pricing models, which evaluate *Homo sapiens* preferences in relationship to a variety of resources and in relationship to several environmental stressors. Based upon the literature review and theoretical framework, one might hypothesize that if habitat quality is defined as the resources and conditions present in an area that produce occupancy, then it would follow that land vacancy would be highly related to poor habitat quality, of which real estate prices are one indicator. The focus of chapters 4-7 is to describe a research methodology to test this hypothesis, the sources and process of data collection, the results and analysis, and conclusions drawn from the research.

## **CHAPTER FOUR: RESEARCH METHODS:**

### **4.1 RESEARCH PROCEDURE**

Chapter Three describes the theoretical framework that underpins this research. In Chapter Four I will discuss the criteria for selection of research methods and describe the research methodology utilized in this analysis. Research procedures in this thesis consist of three parts: first, a theoretical framework, which is developed based on a review of existing theories and principles. The main methodological approach in this part is the literature review. Second, the theoretical framework is a foundation for the guidance of the empirical part of the research, comparative case study, and the selection and application of the selected methods. Third, spatial patterns were analyzed against a set of selected indicators. Finally, the results observed in the various indicators were compared to cross-check the research findings and interpret the results.

As the first step in the research effort, literature reviews, interviews, and site observations across a range of disciplines were utilized. A series of keywords provided direction for additional reading and inquiry and helped to refine the major research questions. The review of literature around each keyword provided a well-rounded understanding of the issues of shrinking cities and a more nuanced approach to understanding the processes of patch dynamics and historical ecology. Keywords utilized in the literature review include:

## KEYWORDS

### Design

- Landscape Architecture
- Architecture
- Urban Design
- City and Regional Planning
- Urban Studies
- Tactical Urbanism
- Risk Based Zoning
- Resiliency Planning
- Urban Renewal
- Racial Zoning

### History and Prehistory

- Archaeology
- History
- Urban Geography
- Archaeological GIS
- Historical GIS

### Political Science

- Political Science
- Community Engagement
- Sociology

### Human Health

- Environmental Epidemiology
- Social Epidemiology
- Cartography
- Medical Geography
- Disease Mapping

### Systems Thinking:

- Physics of Cities
- S Curve of Innovation
- Path Dependency
- Innovator's Dilemma
- Zipf's Law
- Scaling of Systems
- Unintended Consequences
- Innovation Dispersion
- Reverse Engineering

### Economics

- Real Estate Economics
- Urban Economics
- Geographical Underwriting
- Redlining

### Sociology

- Neighborhood Effects
- Spatial Vulnerability
- Social Vulnerability
- Environmental Justice
- Social Justice

### Ecology

- Biology
- Bioremediation
- Phytoremediation
- Urban Agriculture
- Landscape Ecology
- Cultural Ecology
- Historical Ecology
- Environmental History
- Urban Ecology
- Human Ecology
- Restoration Ecology
- Time Series
- Urban Soils
- Urban Forestry
- Subsidence
- Liquefaction
- Anthropogenic Landscapes
- Island Biogeography
- Human Home Range
- Patch Dynamics



The literature review continued throughout the research effort as new information suggested further avenues of inquiry.

## 4.2 RESEARCH METHODOLOGY

### 4.2.1 Establishing the Environmental History of a City

The literature review led to the formulation of a hypothesis: if high habitat quality is defined as the resources and conditions present in an area that produce occupancy, then it would follow that land vacancy would be highly related to poor habitat quality and conversely that high quality habitat would be highly related to occupancy. To test this hypothesis, it was then necessary to create two models to identify habitat quality within the urban ecosystem and to then compare areas of land vacancy against these models. One model identifies quality *Homo sapiens* habitat during the pre-Columbian condition, prior to European settlement (Figure 58). Because many of the conditions that affect the quality of *Homo sapiens* habitat were created by *Homo sapiens* through their own action, a second model identifies quality *Homo sapiens* habitat based upon current conditions.

## A METHODOLOGY FOR VACANT LAND POLICY

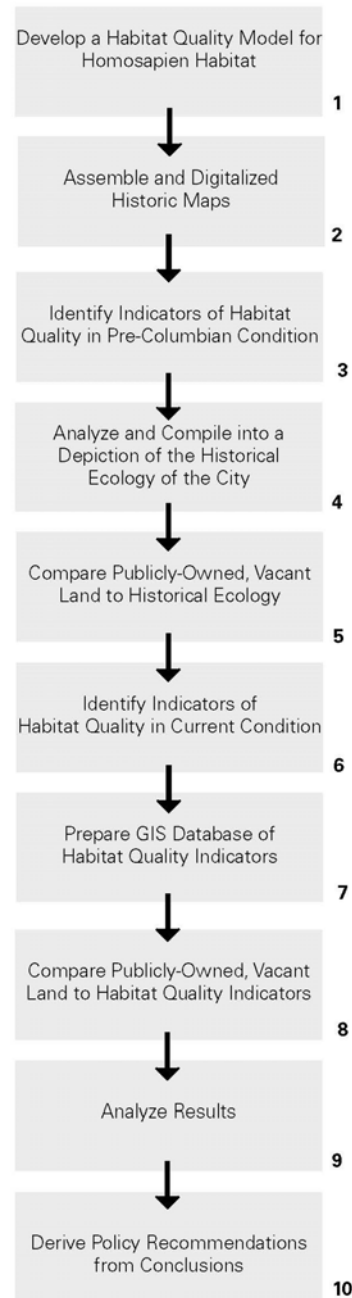


Figure 24 : A Methodology for Vacant Land Policy

The habitat quality model was next used to inform the development of maps using a geographic information system. As outlined in Chapter Three,

proximity to opportunities necessary for healthy *Homo sapiens* habitat were mapped, as well as proximity to risk. Values for each factors were divided evenly into thirds, to create a ternary model classifying areas as optimum *Homo sapiens* habitat, suboptimum *Homo sapiens* habitat, and marginal *Homo sapiens* habitat. This ternary model is similar to the work of Forman who suggested that patches may be classified as bad, good, or interesting. Bad patches are those that provide marginal habitat; good patches are supportive of *Homo sapiens* life (optimum habitat); and interesting patches are those for which conclusions are unclear (suboptimum habitat). These factors were combined in an additive fashion without differentially weighting each factor because too little is known about the relative impact of each factor to make an informed judgement and accurately assign weights.

Publicly owned land vacancy was then compared to a map for each resource and a map of each environmental stressor to evaluate the impact of each on land vacancy by overlaying a map of publicly owned vacant lots with each factor. The number of vacant lots in optimum, suboptimum, and marginal habitat were then counted, and the percentage of the total number of publicly owned vacant lots in each category calculated. Two models were used to more clearly understand the pre-Columbian condition and the impacts of environmental history on the morphology of the city. The pre-Columbian model allowed the impact of geophysical factors such as geology, hydrology, vegetation, to be examined. The second model allowed the impact of conditions created by *Homo sapiens*, including management decisions, proximity to industrial areas and pollution sources, and the impact of infrastructure installations such as major highways and railroads on land vacancy. Historical accounts, and historical maps and illustrations created a spatial summary of the environmental history of the city. This map depicted the patches, corridors (both natural – such as rivers and other waterways and manmade – roadways and rail), and the matrices of the urban landscape. These models are similar to the early work of McHarg who utilized overlapping map layers, each representing a similar theme to determine areas suitable for land use change.

The models utilized in this research differ from McHarg's work in two significant ways. First, where McHarg's methodology was utilized to evaluate "greenfield" sites for urban development, the models utilized in this research were utilized as a diagnostic tool applied to the existing urban fabric. Greenfield sites are areas of land, usually agriculture or timber, which are being considered for urban development. Second, though he did acknowledge the importance of some resources such as prime agricultural lands, McHarg's work focused primarily on environmental constraints or stressors such as steep slopes, floodplains, and geology.

To create the pre-settlement model, it was necessary to determine the environmental history of the site of New Orleans and of St. Louis. Environmental histories and historical accounts were reviewed, and historical maps and imagery were gathered for both cities. If, as Spirn has suggested, an understanding of the environmental history of the city provides insight into the deep structure of the urban ecosystem, how is such an understanding gained? Increasingly, ecologists are utilizing the geo-referencing of historical maps as an educational tool and as a means of understanding the underlying environmental conditions of a landscape.

Geo-referencing has been utilized in a variety of fields. Archaeologists for example, can use geo-referencing to locate ancient fortifications or roadways from historical maps. Landscape architects have utilized geo-referencing to restore historical gardens and cultural landscapes. Medical geographers seek to understand the ecology of disease by geo-referencing historical maps of epidemics. Historians utilize the geo-referencing of old maps to communicate the evolution of the urban environment. Rumsey has created a considerable business through scanning historical maps, with over 5000 now in inventory (Rumsey and Williams, 2002). The Visualizing Urban Geographies project of the National Library of Scotland in Edinburgh is an excellent example of using geo-referencing to illustrate the history of a city.

These mapping techniques are beginning to find their way into city planning and urban design. In Leipzig, Germany, researchers (Haase, et al, 2007)

have utilized a series of geo- referenced maps, dating from 1870, to analyze the increase in impervious surface in the metropolitan area. Utilizing geographic information systems, these researchers assessed the impact of urbanization on groundwater research and the city's water supply and water balance over time. The most extensive effort to map the underlying ecology of an existing city is the Mannahatta Project (1999-2009) of the Wilderness Conservation Society. In 2008, Eric Sanderson and Markley Boyer of the Wilderness Conservation Society re-created a three- dimensional database of the original ecology of the island of Manhattan in New York City (Figure 22). The collaborators utilized early Dutch maps from 1609, as well as British military maps from the period of the American Revolution, to gain a detailed understanding of the original ecology of the city. Today Sanderson's Weilikia Project (2010-2013) seeks to encompass the entire city of New York.

Although Sanderson's *Mannahatta* does a marvelous job in describing the historical ecology of New York and suggests a variety of methods to "green" the city, it stops short of suggesting the re-establishment of the underlying ecological features (Sanderson 2009).



Clearly New York City is not a shrinking city. It has some of the highest land prices in the world, and the idea of removing prime real estate to open now-buried streams or restore lost wetlands or forests would no doubt be met with derision.



Figure 25: Computer Simulation of Manhattan, New York City by Boyer

Yet Sanderson's research methods offer inspiration for those seeking to develop a process to transform shrinking cities where land values do not create a major impediment to transformation. This thesis tests the potential to utilize the underlying ecological conditions of the city – its topography, hydrology, vegetative, and geology – to provide a guiding framework for restructuring.

The idea of re-establishing natural systems within an urban environment is not without precedent. In some cases, such as Bloody Run Creek in Detroit and Spirn's work in West Philadelphia, interventions involve the day-lighting of creeks or streams once relegated to underground storm drains. In others, efforts are being made to restore riparian environments to their former health. These examples include current work to restore the Los Angeles River in California and Bronx River in New York. The Bronx River restoration is guided in large measure by the output

of the Mannahatta project. In San Francisco, historical ecology research is being used as a guide to restore the wetlands of San Francisco Bay. While these are significant and admirable undertakings, each of these efforts seeks to restore only a portion of a major American city. They may provide examples of what is possible, but none has sought to provide a framework for the re-shaping of an entire metropolitan area.

For the purpose of this study, the city limits of the two case studies, New Orleans and St. Louis, were utilized rather than the metropolitan statistical area (MSA). While data on vacant lands within the city limits was available for analysis, data for vacant lands within the entire metropolitan statistical area was not available. For example, East St. Louis, Illinois, another shrinking city, does not maintain a digital database of its vacant lands. While it may be possible to extract such information from the county assessor data such an effort is beyond the scope of this study. Metropolitan statistical areas are established by the Office of Management and Budget, a division of the United States government. Metropolitan statistical areas group counties and cities into specific geographic areas for the purposes of a population census and the compilation of related statistical data.

Metropolitan statistical areas usually consist of a core city with a large population and its surrounding region, which may include several adjacent counties. The area comprised by the MSA is typically marked by significant social and economic interaction. For example, people living in outlying rural areas may commute considerable distances to work, shop or attend social activities in the urban center. Although ecological boundaries, such as a watershed, were examined for both cities, data for vacant lands was not available throughout the entire watershed.

Historical census data and contemporary census information were next mapped to understand the change in census tracts and neighborhoods over time in terms of population, income, net worth, demographic composition, home tenure, the percentage of households living below the poverty level, and land or home values. Where available, this time-series data was analyzed to understand how different areas of the city have undergone economic and other demographic changes over time. Data

was analyzed for as much of the time- scale of analysis (the history of the city) as information is available. In addition, jurisdictional and other management district boundaries are mapped to determine how management activities by *Homo sapiens* may have impacted their health and well-being.

Comparisons were then produced which compare the historical and current geophysical conditions to the health and well-being of the inhabitants. To evaluate the quality of habitat, it was first necessary to define ecosystem health. Ecosystem health is often defined in terms of absence of signs of pathology rather than the presence of signs of health.

In defining ecosystem health, Costanza suggests three attributes: vigor (productivity), organization (including the diversity of biota and their interactions), and resilience (Costanza, et al, 2017). Vigor or productivity is defined as the capacity of the system to sustain the growth and reproduction of both plants and animals. Costanza's definition of vigor in this regard is similar to the definition of biological fitness. This definition of vigor or productivity suggests an ecosystem's ability to support the persistence of a population. Organization is defined as the ability of the system to support a diversity of life forms and their interaction.

Resilience refers to the capacity of the system to buffer perturbations: the capacity to rebound after disturbances such as fires, floods, and hurricanes. Persistence and resilience can also be defined respectively as the ability to remain in a relatively constant state over time and the ability to return to an original state after a perturbation (Grossman, 1982). As McHarg suggested, persistence in this sense can be both positive – supportive of fitness and health or negative – leading to pathology and morbidity.

To understand persistence and resilience, economic and social characteristics of New Orleans and St. Louis were compared over the time from the city's founding to the present utilizing data from Social Explorer to identify areas or patches of persistent high-quality habitat and persistent low-quality habitat. The Social Explorer data allowed the creation of several Powerpoint sequences which illustrate

persistence and change over time. Furthermore, Johnson (2007), has emphasized the importance of measuring habitat quality from the perspective of a population rather than an individual which may seek to maximize its own fitness. Some scholars have sought to develop measures of population persistence but to date there is not a generally accepted methodology for doing so (Burgess, 2014).

In creating the habitat quality model, fifty-five indicators were identified and grouped into of five categories – opportunities, geophysical risks, social risks, and technological risks, and real estate values.

An evaluation was then made to determine if development in conflict with the environmental history of the city has created poor conditions for *Homo sapiens* health and well-being. The spatial impacts of major management decisions including racial zoning, racial covenants, redlining, urban renewal programs, and historical and current zoning patterns were mapped and compared to the location of publicly owned vacant lands. Then the location of publicly owned vacant lands was compared to the location of technological risks such as industrial lands and to the location of major highways, rail lines, and other major infrastructure. Finally, the location of publicly owned vacant land parcels in New Orleans and St. Louis were overlaid on maps of various types of pollution obtained from the Environmental Protection Agency EJScreen (environmental justice screen) database to understand the impacts of pollution on land vacancy. Public health data, crime statistics, and level of educational attainment provide measures of public health and well-being in the social dimension.

Finally, to test the relationship between publicly owned land vacancy and real estate values, a map of publicly owned vacant lots was overlaid on a map of median home prices.

#### **4.3 KEY CONCLUSIONS**

Chapter Four has defined the research approach that investigated the relationship between historical ecology and land vacancy. An understanding of economic and social patterns over time was recognized as crucial to understanding spatial patterns and contributing to better future planning and management of vacant lands. As a basis for the implementation of the selected methods, two case study cities, New Orleans and St. Louis, were chosen, to allow the comparison of the research findings.

Based on the critical comparison of different methods, the relevant information was extracted, and the patterns were elucidated. The implementation of the methods and their analysis, on an operational level, is described in the next three chapters (Five to Seven).

## **CHAPTER FIVE: DATA COLLECTION**

### **5.1 TIME-SERIES DATA AND ENVIRONMENTAL HISTORY**

Understanding the environmental history of a city over time requires time-series data, both ecological and demographic. Time-series data is a series of values obtained at successive times, often with equal intervals between them. By comparing historical maps and accounts of the city with demographic data, calculations were made of population density and other measures. However, the variation of this demographic data over time makes accurate and statistically valid comparisons over time difficult. As all census count population, it is possible to calculate population density over time from 1790 to present.

New Orleans was founded in 1718 and St. Louis in 1764, but the first decennial United States census was conducted in 1790 and did not contain data for New Orleans or St. Louis. An understanding of the population of these cities prior to the first census to include these cities (1810) can largely only come from historical accounts (30.9 percent of the history of New Orleans, and 18.3 percent of the history of St. Louis are not covered by census data). The absence of data from the early years of the settlement of these cities is one limitation of the available data. Furthermore, no demographic or census data is available for the period of the pre-European settlement of the sites of New Orleans and St. Louis.

The lack of data is in part explained by the fact that both cities were part of different countries for much of their early years. St. Louis was ceded to Spain by France in 1770. The secret treaty of St. Ildefonso in 1800 ceded the Louisiana Territory from Spain back to France. Though founded by the French, New Orleans was an administrative unit of the Viceroyalty of New Spain from 1762 to 1802, and like St. Louis was retroceded to France under the secret treaty of St. Ildefonso in 1800 and the Treat of Aranjuez in 1801. The Spanish continued to administer the city until 1803 when formal transfer to the French occurred, prior to the sale of the

Louisiana Purchase by France to the United States that year. New Orleans and St. Louis have thus been part of the United States for 214 years. Changes in the laws under which these cities were managed likely impacted the physical forms of both cities. The analysis of longitudinal demographic data is also difficult because the categories in which data is collected changes over time. Definitions change, some categories appear and then disappear in the data (for example, the number of slaves were measured before the Emancipation Proclamation, the law granting freedom to African-Americans, in 1863). The professionalism of data gatherers also varies over time.

The French government compiled 28 censuses for the Louisiana territory between 1699 and 1732. These censuses are for the entire Louisiana territory making it difficult to isolate demographic data for New Orleans.

St. Louis was founded in 1764 by August Choteau and a group of 30 men. By 1770 the population numbered 500. A census by the Spanish lieutenant-governor Delassus in 1798 showed that the population of St. Louis had grown to 925 inhabitants. In the first United States census in 1790, assistant marshals listed the name of each head of household, and identified the number of free whites and females, the number of other free persons, and the number of slaves. In the second census in 1800, assistant marshals recorded the name of the county, parish, township, town, or city in which each family resided. A set of questions like the 1790 census were asked but the age of white females was also included in the data.

In 1805, a census of New Orleans showed a heterogeneous population of 8,500, comprising 3,551 whites (41.7%), 1,556 free blacks (18.3%), and 3,105 slaves (36.5%). Observers at the time and historians since believe there was an undercount and the true population was about 10,000 (Din and Harkinshe, 1996).

In 1810, the list of questions asked by assistant United States marshals was identical to the 1800 census. This census recorded the name of the county, parish, township, town, or city in which each family resided. For example, Orleans Parish which contains the city of New Orleans first appears in 1810, and data for both New

Orleans and St. Louis separate from their parish and county appear from the 1820 census onward. The number of free male and females were recorded by age, as was the number of “all other free persons,” and the number of slaves. In addition to population inquiries, the 1810 census was the first to collect data about the nation's manufactures. To facilitate data collection, the Treasury Department divided manufactured products into 25 broad categories, encompassing more than 220 kinds of goods. As the United States marshals and their assistants conducted the decennial census, they also visited the manufacturing establishments in their assigned areas to obtain economic data. This data generally consisted of the quantity and value of products manufactured.

Both New Orleans and St. Louis are delineated by wards in the 1820 census. The 1820 census were built on the questions asked in 1810. The 1820 population is the first to identify the “colored” population of New Orleans. From this census to the 2014 census, the African American population is variously identified as “colored,” “black,” or “African American.” The definition of individuals included within category of African American varies over time. It is not until 1940 that this data is recorded by census tracts.

The 1830 census began to break population counts in New Orleans into sub-areas – the three separate municipalities of the city. Census data from 1830 for St. Louis was only for St. Louis county (though the town of St. Louis was the clear majority of the county’s population). The census becomes more robust over time with more and more categories of information available as one moves forward in time. For the 1830 census, the age categories were expanded again. Additionally, some social categories made their first appearance.

The 1840 census quantified the free white, free colored, and slave population of both New Orleans and St. Louis, identified employment by industry and educational attainment, and quantified the number of deaf, dumb, and blind both white and slave.



The 1850 census is the first to record mortality statistics and real estate statistics, in this case, the value of farm properties. For the first time, free persons were listed individually instead of by family. There were two questionnaires utilized in the census one for free inhabitants and one for slaves. New Orleans was not divided into wards until 1852 when most of the boundaries of Wards 1 through 11 were drawn when the city was reorganized from three separate municipalities into one centralized government.

The 1860 census of New Orleans is the first to record population and other statistics by ward. There were multiple questionnaires used for the 1860 census, including a separate slave questionnaire (which collected the same information as in 1850). Residents were identified by white, black, or mulattos.

The 1870 census delineated New Orleans and St. Louis by ward. The decennial census has always required a large workforce to visit and collect data from households. Between 1790 and 1870, the duty of collecting census data fell upon the United States Marshals. In the 1880 census, the United States Marshals were replaced with specially hired and trained census-takers to conduct the 1880 and subsequent censuses. During the early censuses, United States Marshalls received little training or instruction on how to collect census data. In fact, it was not until 1830 that marshals even received printed schedules on which to record households' responses. The marshals often received limited instruction from the census acts passed prior to each census.

Beginning with the 1880 census, specially hired and trained census-takers replaced the United States marshals. Door-to-door census by temporary census-takers was the primary method of conducting the census until the United States Census Bureau began mailing questionnaires to households in 1960. Enumerators identified residents as white, black, mulatto, Chinese, or American Indian.

The census of 1880 is widely viewed as the first "professional" census. A lack of professionalism, inconsistency in data collected, and the intrusion of politics and fraud make the accuracy of census data before 1880 often suspect as well.

However, utilizing data beginning with this first professional census eliminates 162 years of time-series analysis for New Orleans (54% of the city's history) and 116 years of time-series analysis for St. Louis (46% of the city's history) and the city's formative years when patterns of poverty and health were initially established. Utilizing all available census data allows a researcher to interpret general trends but prior to 1880, specific numbers should be treated with skepticism. For the 1880 census, enumerators identified residents as white, black, mulatto, Chinese, or American Indian.

The practical function of the enumeration district in 1880 was to define the area within which a given enumerator was contracted to gather data. A written description of the boundaries has survived for much of the country in the form of a listing of enumerators and the areas for which they were responsible. Unfortunately, they often do not have very clear boundaries. District Supervisors were chosen for their familiarity with their region, and when defining enumeration districts, they provided only enough information to guide the census taker, who was also a resident familiar with the area. The result is descriptions that occasionally include prominent but idiosyncratic features. Examples include fences between houses, obsolete political boundaries, minor water features that have since been moved underground, and in both New Orleans and St. Louis, shorelines that have been radically changed through infill or dredging, alleys, and hill crests. One recurring problem is the use of an outdated or informal name for features that are crucial for defining the limits of a boundary. Another common problem is a boundary described as following an extension of a street until it reaches the city limits, which is problematic if that street never existed or was extended in a different direction after 1880.

From this first professional census in 1880, the United States census has continued to evolve and change. Changes in the census over time make longitudinal analysis difficult. Boundaries change, definitions change, and the categories for which data are collected all vary over time. Nonetheless, the United States census provides the best available source of data over the history of New Orleans and St. Louis. Information was gathered for both cities for income, unemployment, poverty, home tenure, population density, and racial diversity.

By analyzing time series data of New Orleans population the following table was created. The developed area at the time of each census was determined by digitizing historic maps from the year of the census. Population density at the time of the census, was determined by dividing the population by the developed acres.

Population of New Orleans					Population Density for 2018		
Census Population	Rank Order Among American Cities	Population Density Per Acre of Developed Area	Square Miles of Developed Area	Population Per Square Mile Of Developed Area	City Limits (132692 Gross Acres)	Population Per Square Mile for 2018 City Limits	
1723	1249	N/A	4.8	0.4	3074.46	0.01	6.02
1730	1499	N/A	5.8	0.4	3689.85	0.01	7.23
1740	1748	N/A	6.7	0.4	4302.77	0.01	8.43
1750	2000	N/A	7.7	0.4	4923.08	0.02	9.65
1760	2524	N/A	9.7	0.4	6212.92	0.02	12.17
1770	3190	N/A	12.3	0.4	7852.31	0.02	15.39
1780	4960	N/A	19.1	0.4	12209.23	0.04	23.92
1790	6480	N/A	21.6	0.5	13824.00	0.05	31.25
1800	8000	N/A	26.7	0.5	17066.67	0.06	38.59
1810	17212	7	57.4	0.5	36718.93	0.13	83.02
1820	27176	5	90.6	0.5	57975.47	0.20	131.08
1830	46082	5	20.0	3.6	12817.24	0.35	222.26
1840	102193	3	14.2	11.3	9083.82	0.77	492.90
1850	116375	5	11.3	16.1	7210.77	0.88	561.30
1860	168675	6	12.5	21.0	8021.40	1.27	813.56
1870	191418	9	12.9	23.2	8267.48	1.44	923.25
1880	216090	10	10.1	33.5	6448.64	1.63	1042.25
1890	242039	12	11.3	33.5	7223.02	1.82	1167.41
1900	287104	12	13.4	33.5	8567.87	2.16	1384.77
1910	339075	15	15.8	33.5	10118.81	2.56	1635.44
1920	387219	17	13.3	45.6	8488.15	2.92	1867.65
1930	458762	16	21.4	33.5	13690.56	3.46	2212.71
1940	494537	15	23.1	33.5	14758.17	3.73	2385.27
1950	570445	16	17.7	50.3	11342.26	4.30	2751.39
1960	627525	15	19.0	51.7	12145.52	4.73	3026.70
1970	593471	17	11.9	77.8	7633.07	4.47	2862.45
1980	557515	21	11.2	77.8	7170.61	4.20	2689.02
1990	496938	24	10.0	77.8	6391.49	3.75	2396.85
2000	484674	31	9.7	77.8	6233.75	3.65	2337.69
2010	343829	51	6.9	77.8	4422.24	2.59	1658.37

Table One: Population and Density in New Orleans Over Time

A similar table was created in the same way for St. Louis.

Population of St. Louis

Census	Population	Rank Among American Cities	Acres of Developed Areas	Square Miles of Developed Area	Population Density Per Developed Acre	Population Density Per Square Mile Of Developed Area	Population Density Per Acre for 2018 City Limits (42230 Acres)	Population Density for 2018 City Limits Per Square Mile
1764	120	N/A	62.00	0.10	1.94	1238.71	1.82	1.82
1770	577	N/A	62.00	0.10	9.31	5956.13	0.01	8.74
1780	687	N/A	62.00	0.10	11.08	7061.61	0.02	10.41
1790	897	N/A	62.00	0.10	14.47	9259.35	0.02	13.59
1800	925	N/A	62.00	0.10	14.92	9548.39	0.02	14.02
1810	1600	N/A	62.00	0.10	25.81	16516.13	0.04	24.24
1820	4928	N/A	419.00	0.74	11.76	6659.46	0.12	74.67
1830	3852	37	901.00	1.41	6.50	4156.80	0.14	88.67
1840	16496	24	3452.00	5.39	4.78	3058.35	0.39	249.94
1850	77860	8	4986.00	7.79	15.62	9994.06	1.04	1179.70
1860	160773	8	9972.00	15.58	16.12	10818.36	3.81	2435.95
1870	310864	4	11507.00	17.98	27.02	17289.73	7.36	4710.06
1880	350518	6	21118.00	33.00	16.60	10622.76	8.30	5310.88
1890	451770	5	30729.00	48.01	14.70	9409.12	10.70	6845.00
1900	575238	4	31144.00	48.86	18.47	11820.97	13.62	8715.73
1910	687029	4	32584.00	50.91	21.08	13494.31	16.27	10409.53
1920	772897	6	32640.00	51.00	23.68	15154.84	18.30	11710.56
1930	821960	7	37440.00	58.50	21.95	14050.60	19.46	12453.94
1940	821960	8	42240.00	66.00	19.46	12453.94	19.46	12453.94
1950	856796	8	42240.00	66.00	20.28	12981.76	20.29	12981.76
1960	750026	10	42240.00	66.00	17.76	11364.03	17.76	11364.03
1970	622236	18	42240.00	66.00	14.73	9427.82	14.73	9427.82
1980	453085	26	42240.00	66.00	10.73	6864.92	10.73	6864.92
1990	396685	34	42240.00	66.00	9.39	6010.38	9.39	6010.38
2000	348189	48	42240.00	66.00	8.24	5275.59	8.25	5275.59
2010	319284	57	42240.00	66.00	7.56	4837.79	7.56	4837.79
2016	315685	N/A	42240.00	66.00	7.47	4783.11	7.48	4783.11

Table Two: Population and Density in St. Louis Over Time

## 5.2 THE ACCURACY OF MAPS OVER TIME AND THE CHALLENGES OF GEO-REFERENCING

Another form of time-series data gathered was historical maps of each city reflecting urban development. Historical maps were collected for both New Orleans and St. Louis. At least one map was collected for every ten years of each city's history. Preference was given to maps which aligned with the years of the decennial census so that a comparison can be made between socio-economic data and spatial data.

Comparison of demographic (census) and map data was complicated by the fact that while maps for both New Orleans and St. Louis can be found on roughly ten year intervals (if not more frequently), seldom do the dates of maps and the dates of the decennial census perfectly align. For example, a map of New Orleans from 1819 was found but not for 1820, the year of the census. Therefore, conclusions drawn by

comparing the physical condition of the city with the demographic situation are approximate.

A wide variety of skill was undoubtedly used by cartographers over the decades in preparing the various historical maps used in this analysis. Survey benchmarks changed over time and the quality of surveying instruments no doubt improved as well. Maps created for different purposes requiring varying degrees of precision. Some were for commercial purposes, others for military use, and others prepared by the government for a wide range of uses. Not all maps covered the entire city. Many, particularly those prepared for commercial purposes, cover only the downtown areas and major residential areas, making calculation of the developed areas of the city and related calculations at times difficult. For this reason, all historical maps found as part of this analysis were georeferenced and a reasoned judgment made to determine the location of historical features. For example, the location of Chouteau's Pond in St. Louis appears in slightly different shapes and forms in maps from 1796-1844. The pond was filled in 1849 in response to a cholera outbreak in the city.

Systematic mapping of the nations' topography began in 1879 when the United States Geological Service (USGS) began its work. In 1884, the United States Congress authorized periodic mapping of the United States. Map scales have varied over time. Smaller scale maps, showing more area and less detail, were produced in the 1800s. These maps included the 1:125,000-scale, a 30-minute map covering 30-minutes of latitude and longitude with one inch equaling two miles in distance. In the early 20<sup>th</sup> century the 15-minute, or 1: 62,500-scale maps were introduced with more detail than the earlier series. Currently 7.5-minute, or 1: 24,000-scale maps covering 70 square miles where one-inch equals 2,000 feet. Map symbology also has changed over time. After World War II, the USGS adopted photogrammetry as a part of the mapping process. Computer assisted technology was incorporated into the process in the 1970s. The USGS prepared maps of the New Orleans area in 1939, 1951, 1966, and 1970.

Digital elevation models (DEM) allow a three-dimensional representation of the earth's surface. The format dates from 1992. The Spot 1 satellite in 1986 provided the first digital coverage of a large portion of the earth's surface. Because digital topographic data only covers a short portion of history of New Orleans and St. Louis, without a major digitizing effort, a detailed analysis of the impact of slope on the urban form of New Orleans and St. Louis was beyond the scope of this study. Certainly, New Orleans is extremely flat and steep slopes were clearly not an issue in the city's development. St. Louis, however, would have had areas of steep slope but the loess hills of the city would have easily been graded to meet the needs of development.

With the invention of the airplane, aerial photography became available for St. Louis in 1937 with city-wide flights of the city, and such city-wide aerial photography for St. Louis was utilized in the research in 1937, 1955, 1966, 1970-72, 2000, 2002, 2004, 2006, 2008, and 2010. Comprehensive city-wide aerial photographs for New Orleans are available for 1949 and 1960, with selective examples scattered throughout of specific subject areas (such as the port, for instance, or industrial areas along the Mississippi River), but these images are found in various archives throughout the community and no comprehensive inventory or documentation of the purposes for which they were executed now exists. In 1972, the United States started the Landsat program and satellite imagery has been available from that time.

The ability to geo-reference maps accurately varies with the quality of the imagery of the historical maps. The availability of known features in both the historical maps and contemporary aerial or satellite photography also greatly facilitated the effort. In geo-referencing maps of New Orleans, for example, it was relatively easy to align maps of the gridded streets of the Vieux Carré (French Quarter) with current aerial photography. However, at the margins of the map, features often did not align as accurately. Similarly, the original streets of the original town site of St. Louis provided reliable basis for geo-referencing. It is also not clear whether the streets represented on maps from various periods are depicted

by the pavement surface or street right of way, or simply a general approximation of the street location.

While the location of the Mississippi River in both cities is generally constant over time, the filling and erosion of the river banks over time made utilizing the river banks as a reliable geo-reference difficult. These challenges suggest either limitations in the application of geo-referencing techniques or inaccuracies in the historical maps. When maps are not scanned at high resolution, the image becomes pixelated, making geo-referencing of detailed map features difficult. One can speculate that the primary focus of the makers of these historical maps was in the accurate mapping of the developed portion of the city, and that features in the surrounding countryside were less important and mapped with a lower level of precision.

Nonetheless, by geo-referencing and digitizing multiple maps over the entire period of each city's history and comparing the results, a reasoned approximation of the evolution of the city over time and the location of features such as the marshes and swamps of New Orleans or the location of Bayou St. John or Bayou Gentilly in New Orleans or the location of Choteau's Pond or Mill Creek in St. Louis was generated with confidence.

An excellent sense of the evolution of New Orleans and St. Louis can be gained over time using the *Timelapse* feature of the Google Earth Engine program. *Timelapse* is a zoomable video that allows the viewer to see how the Earth has changed over the past 32 years. It is made from 33 cloud-free annual mosaics, one for each year from 1984 to 2016, which are made interactively explorable by Carnegie Mellon University CREATE Lab's Time Machine library, a technology for creating and viewing zoomable and pan-able time lapses over space and time.

Google Earth Engine combined over 5 million satellite images acquired over the past three decades by five different satellites. Most of the images come from Landsat, a joint USGS/NASA Earth observation program that has observed the Earth since the 1970s. For 2015 and 2016, Landsat 8 imagery was combined with imagery

from Sentinel-2A, part of the European Commission and European Space Agency's Copernicus Earth observation program. As can be seen from this *Timelapse* sequence of New Orleans [<https://earthengine.google.com/timelapse/#v=29.95107,-90.07153,10,latLng&t=0.09>], the overall developed area of the New Orleans metropolitan area has changed little from 1984 to 2016. Very little change is visible in these satellite images. A time lapse of demographic factors over the same period, however, shows consideration shifts in racial composition, incomes, and other factors. Similarly, a *Timelapse* of St. Louis [<https://earthengine.google.com/timelapse/#v=38.627,-90.1994,10,latLng&t=1.41>] shows that land use changes within the city during this 32-year period are relatively minor. Growth beyond the city limit boundaries in the balance of St. Louis County is easily visible. Though physical change as viewed via satellite imagery may be minor, similar time lapse mapping of demographic data utilizing Social Explorer, provides a visualization of social change in New Orleans and St. Louis.

A time lapse of change in population density in New Orleans from 1790 to 2016 demonstrated how changes in the collection methods and boundaries for census data provides varying results in map display (See Appendix). A time lapse of race in St. Louis from 1790 to present provided a visualization of change in the city as the non-white population moves first into the Mill Creek Valley, gradually westward, and then north into North St. Louis and then further north toward Hazelwood, Ferguson, and Spanish Lakes. These images provided a visualization of patch dynamics in action.

### **5.3 LAND VACANCY OVER TIME – THE AVAILABILITY OF DATA FOR NEW ORLEANS AND ST. LOUIS**

In addition to time-series data provided by historical maps and by census data, a longitudinal study of vacant lands in New Orleans and St. Louis would be aided by data on land and building vacancies over time. Unfortunately, this data is not available. Unlike historical maps and census data, data on land vacancy over time is far more



difficult to obtain. The New Orleans Redevelopment Authority (NORA) does not have GIS capabilities and is dependent upon the City of New Orleans GIS department. The Land Redevelopment Authority (LRA) similarly depends upon the City of St. Louis for its GIS data base. Thus, only parcel and building vacancies for 2012 and 2014 are available. Fortunately, both the city of New Orleans and the Land Redevelopment Authority (LRA) have retained the Reinvestment Foundation to conduct market assessments which in turn are utilized to guide New Orleans' and St. Louis' decisions regarding vacant land. The Reinvestment Fund conducted a market value analysis for New Orleans in 2013 and for St. Louis in 2014. Historical aerial or satellite photographs were also utilized to identify vacant lands but, unlike databases of city-owned vacant lands, it was not possible to determine the ownership of these parcels. Vacancy and land ownership of individual parcels can also be determined from St. Louis County or Orleans Parish assessor's information, but this information is updated in real time and did not provide longitudinal data. While this data was very useful to the analysis, the lack of data over a long-time scale made the identification of persistent patches of vacancy difficult. Data was certainly not available for the entire course of the history of New Orleans or St. Louis, or for the period for which quality demographic data is available.

A comparison of vacant land parcels for New Orleans and St. Louis showed that the two cities have not kept land vacancy records for the same years. The shapefiles utilized for New Orleans are an inventory of 2012 parcel vacancies. For St. Louis, the inventory is for 2014. Ideally, this information would be recorded by the City of New Orleans and the City of St. Louis over time so that shifts in vacancy in the city could be evaluated in greater detail. Unfortunately, this was not the case. In New Orleans, the high level of vacancy in the Lakeshore neighborhood is a result of levee breaches during Katrina in 2005. This neighborhood has yet to fully recover from the hurricane and presents an outlier to other conditions observed in New Orleans. Time-Series Data for Land Values:

Time-series data for land values is difficult to obtain. The Reinvestment Foundation market value analysis certainly provides such data but only for 2013 to present. Land values could also be determined from St. Louis County or Orleans

Parish assessor's information, but this information is updated in real time and did not provide longitudinal data. While this data was very useful to the analysis, the lack of data over a long-time made the identification of persistent patches of high and low real estate values difficult.

## **5.4 KEY CONCLUSIONS**

Information has been gathered for a wide variety of purposes and formats. Seldom was it gathered with the goal of an integrated look at *Homo sapiens* habitat, but rather to answer specific questions. Increasing there are emerging efforts at universal wide indicator systems such as the Kirwan opportunity maps or the social vulnerability index maps of the Center for Disease Control. This research aimed to identify information to address over fifty potential indicators of habitat quality for *Homo sapiens* and to develop a comprehensive system that allowed comparison between cities.

## **CHAPTER SIX: ANALYSIS AND RESULTS**

### **6.1 BIENVILLE'S DILEMMA: LESSONS FROM NEW ORLEANS**

Chapter 3 described the theoretical framework that guides this thesis. Chapter 4 describes the methodology utilized and Chapter 5 the process of data collection. This chapter describes the results of the application of the methods and the analysis of the results.

As outlined in the methodology, historical maps were georeferenced and digitized to create a map which depicts the Historical Ecology of New Orleans Prior to European Settlement (Figure 26). The site of the City of New Orleans was characterized by bottomland hardwood forest which occupied the natural levees and the Mississippi River, Bayou Metairie, and Bayou Gentilly.

Recent mapping suggests a more complex ecology for the New Orleans site than can be gleaned from historical maps, but the basic structure of the ecological system identified by the historical analysis remains. This is understandable for many reasons. The purpose of early maps was wayfinding not environmental analysis, so early cartographers likely only recording vegetation types and environmental features in sufficient detail to facilitate wayfinding.

Land vacancy was then compared to the habitat Quality Model: Prior to European Settlement (Figure 27) to understand the relationships between historical ecology and land vacant. Fully eighty percent of vacant land parcels in current New Orleans are on wetlands and other lands subject to flooding that would be considered marginal habitat.

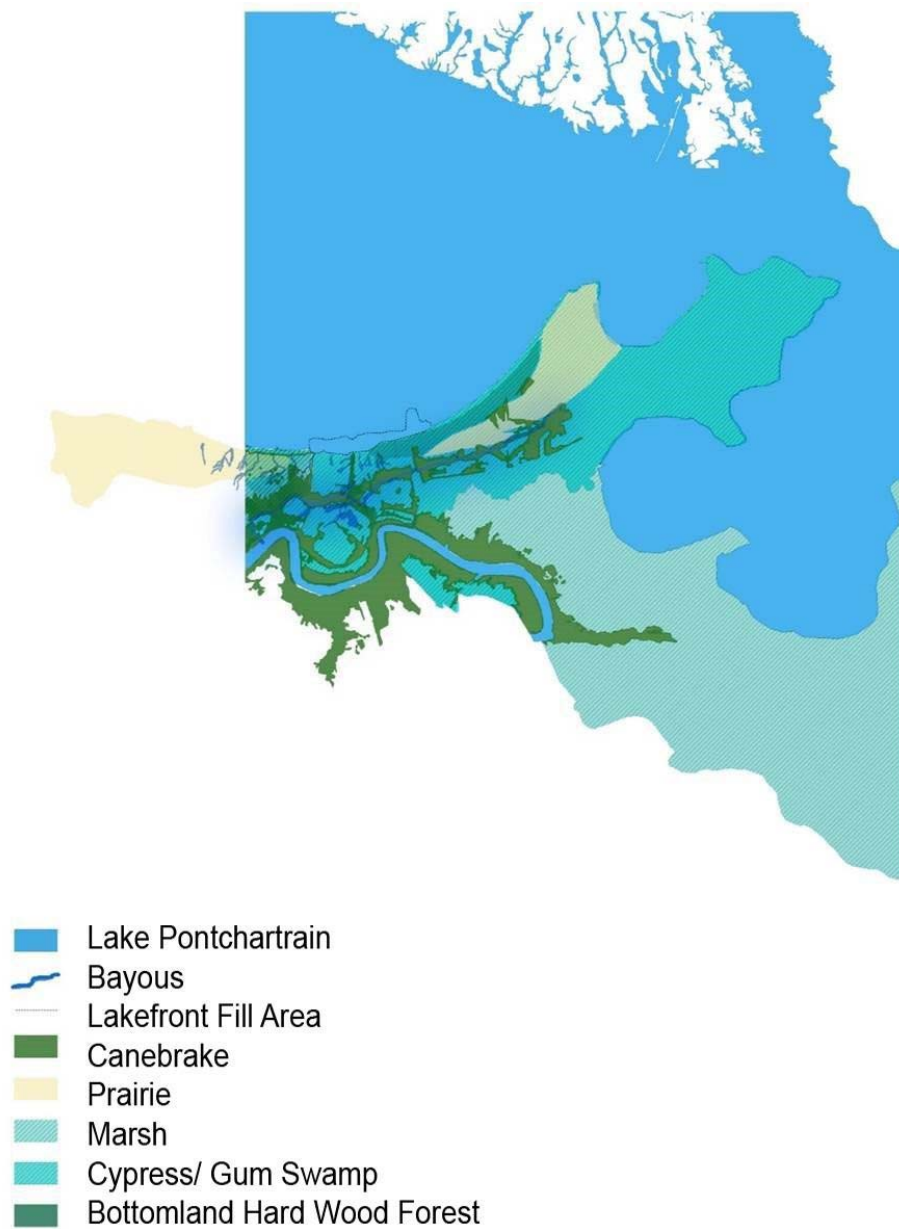


Figure 26: Historical Ecology of New Orleans

### 6.1.1 Habitat Quality Map of New Orleans Prior to European Settlement

From the Map of Historical Ecology of New Orleans, a ternary Habitat Quality Model was conceived. The high ground which contained bottomland hardwood forest was classified as optimum habitat because it was the portion of the site of the city that was least prone to periodic flooding and water borne illness. The prairie landscapes were classified as suboptimum habitat. The marshes, cypress/gum

swamp, and canebrake landscapes were classified as marginal habitat because of the occurrence of frequent and severe flooding.

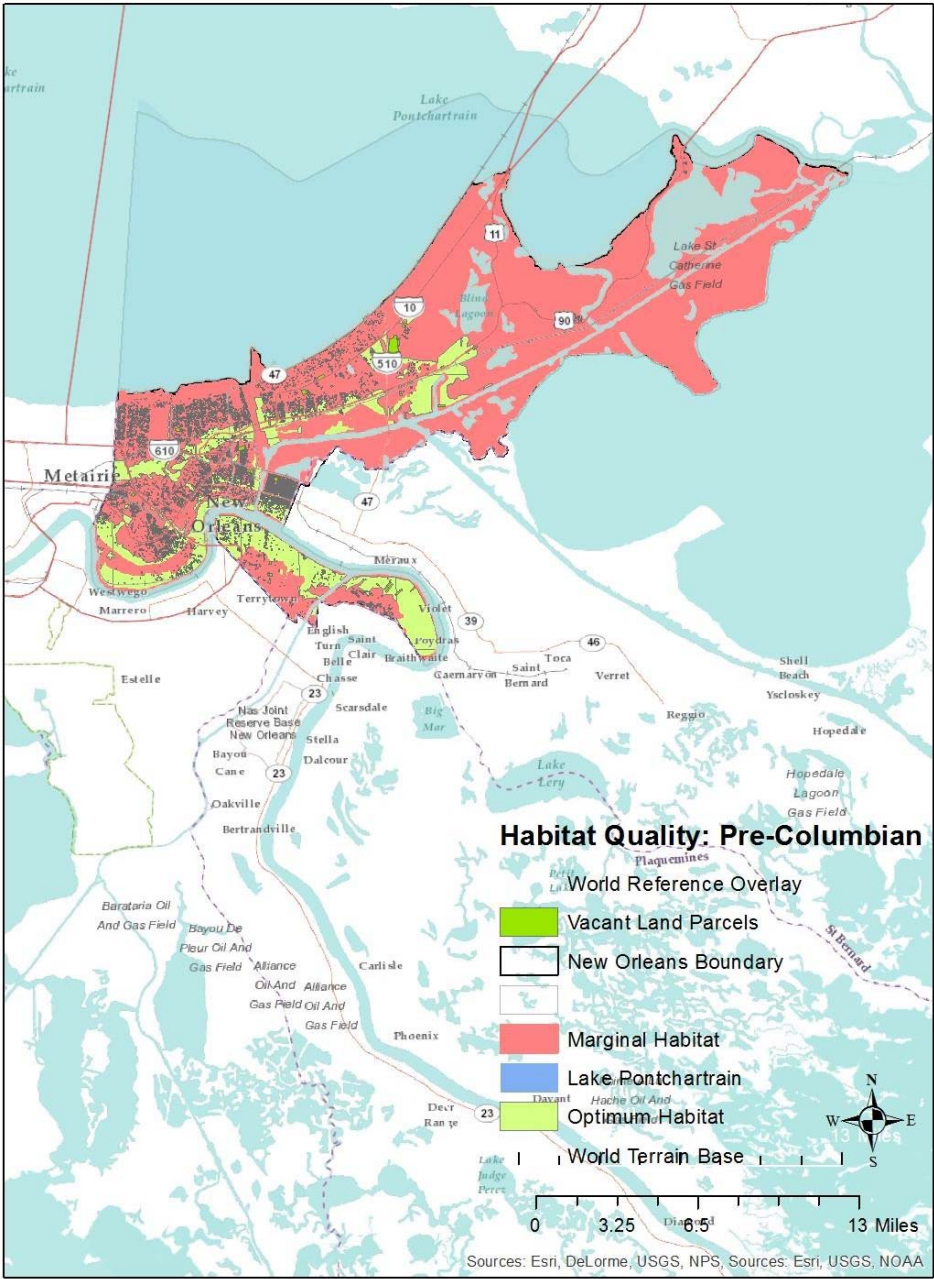


Figure 27: Habitat Quality Model of New Orleans: Prior to European Settlement

Vacant land parcels were then overlaid over the Habitat Quality Map of conditions prior to European settlement were examined. Of the vacant land parcels in New Orleans, eighty percent are on land that would be considered marginal or suboptimum habitat due to their location in flood prone areas and wetlands. Twenty-percent are on lands considered optimum habitat.

### **6.1.2 Habitat Quality Model of New Orleans – Present**

A habitat quality model was conceived which examined vacant land in New Orleans against factors in five categories: proximity to opportunity, proximity to geophysical risks, management decisions, proximity to technological risks, and proximity to social risks. A map layer of vacant land parcels was laid over map layers of each of the individual opportunities and risks to understand those relationships. The percentage of the total vacant land parcels with optimum, suboptimum, and marginal habitat was then calculated. Some factors were eliminated from the model because data was not available at a census tract level and provided no differentiation of habitat quality. This included access to energy resources and exposure to ozone and pm 2.5 pollution. Information on proximity to quality education and unemployment was also not available on a census tract basis and thus the influence of these factors could not be considered independently. These factors were contained within the Kirwan Institute opportunity maps and were evaluated utilizing this information. In addition, information technology was physically available to all residents though perhaps not accessible based upon affordability but was not considered a differentiation of habitat quality. Tax policy was uniform across the city and thus also offered not differentiation of habitat quality. Because of the lack of data for classification, no effort was made to categorize habitat based upon proximity to cultural resources or the quality of urban design. A summary of these results is contained within the following table. The results for both New Orleans and St. Louis are indicated to allow a comparison between each city for each opportunity and risk. In the GIS maps contained within this thesis, data is divided into six tranches instead of three (optimum, suboptimum, and marginal) to allow a more nuanced visual interpretation of the data. For calculation purposes, however, three tranches were used.

SUMMARY OF HABITAT QUALITY IN NEW ORLEANS AND ST. LOUIS

		NEW ORLEANS			ST. LOUIS		
		Optimum	Suboptimum	Marginal	Optimum	Suboptimum	Marginal
<b>OPPORTUNITIES</b>							
	Overall Opportunity	14	16	70	3	4	93
	Educational Opportunity	23	18	59	3	6	92
	Social and Economic Opportunity	19	16	65	9	10	82
	Health and Environmental Opportunity	12	10	78	8	2	90
	<i>Subtotal Kinwan Opportunity</i>	17	15	68	6	5	89
	Travel Time to Employment	32	43	25	13	22	65
	Educational Opportunity	N/A	N/A	N/A	N/A	N/A	N/A
	Information Technology	N/A	N/A	N/A	N/A	N/A	N/A
	Energy	N/A	N/A	N/A	N/A	N/A	N/A
	Food Supply	0	39	61	16	0	84
	Cultural Resources	N/A	N/A	N/A	N/A	N/A	N/A
	Parks and Open Space	84	7	9	92	3	5
	Views	N/A	N/A	N/A	N/A	N/A	N/A
	Urban Design	N/A	N/A	N/A	N/A	N/A	N/A
	<i>Subtotal Opportunity</i>	25	21	54	19	7	75
<b>GEOPHYSICAL RISKS</b>							
	Soils and Geology						
	Subsidence	49	40	11	N/A	N/A	N/A
	Collapse Potential	N/A	N/A	N/A	99	0	1
	Landslide	N/A	N/A	N/A	97	0	3
	Liquefaction	N/A	N/A	N/A	87	0	13
	Sea Island Rise	7	51	42	N/A	N/A	N/A
	Floodplain	8	31	61	99	0	1
	Wetlands	20	0	80	100	0	0
	Vegetation	N/A	N/A	N/A	N/A	N/A	N/A
	Tornado and Hurricane Risk	N/A	N/A	N/A	N/A	N/A	N/A
	<i>Subtotal Geophysical Risk</i>	20	31	49	97	0	3
<b>SOCIAL RISKS</b>							
	Racial Covenants	N/A	N/A	N/A	N/A	N/A	N/A
	Redlining	10	28	62	1	29	70
	Urban Renewal	N/A	N/A	N/A	28	14	58
	Public Housing Projects	N/A	N/A	N/A	N/A	N/A	N/A
	Median Household Income	14	50	36	0	12	88
	Unemployment	N/A	N/A	N/A	N/A	N/A	N/A
	Crime	N/A	N/A	N/A	N/A	N/A	N/A
	Race (African-American)	31	16	53	28	22	50
	Home Tenure (Renter/Owner Ratio)	27	69	4	5	6	89
	Poverty	24	63	13	5	29	66
	Diversity Index	41	49	10	28	22	50
	Dissimilarity Index (Thiel Index)	37	53	10			
	Social Vulnerability						
	SocioEconomic	18	13	69	2	8	90
	Housing Composition/Diversity	33	21	46	9	15	76
	Minority Population/Language	13	31	56	0	61	39
	Housing and Transportation	44	13	43	7	20	73
	Average SVI	27	20	54	5	26	69.5
	<i>Subtotal Social Total Risk</i>	29	41	40	13	26	83
	Tax Policy	N/A	N/A	N/A	N/A	N/A	N/A
	<i>Subtotal Social Total Risk</i>	27	37	37	13	26	83
<b>TECHNOLOGICAL RISK</b>							
	Noise	7	32	61	5	46	49
	DSLPM	1	6	93	0	0	100
	CANCER	2	26	72	0	0	100
	RESPIRATORY	2	71	27	0	0	100
	TRAFFIC	18	33	49	18	33	49
	PMDIS	18	20	80	0	22	78
	PPNPL	0	8	92	0	18	82
	PPRMP	1	18	81	0	13	87
	TSDF	0	62	38	0	13	87
	Ozone	N/A	N/A	N/A	N/A	N/A	N/A
	PM2.5	5	17	78	N/A	N/A	N/A
	Lead	10	18	72	9	12	85
	Pipelines and Powerlines	N/A	N/A	N/A	N/A	N/A	N/A
	Landfills and Incinerators	N/A	N/A	N/A	N/A	N/A	N/A
	<i>Average of Technological Risks</i>	6	28	68	3	14	74
<b>AVERAGE OF OPPORTUNITY AND ALL RISKS</b>		19	29	52	33	12	59
<b>Real Estate Values and Vacancy</b>							
	Median Home Value	2	25	73	13	14	73

Table 3: Composite Summary of Habitat Quality Model: Present Conditions



### 6.1.1 Proximity to Opportunities and Land Vacancy

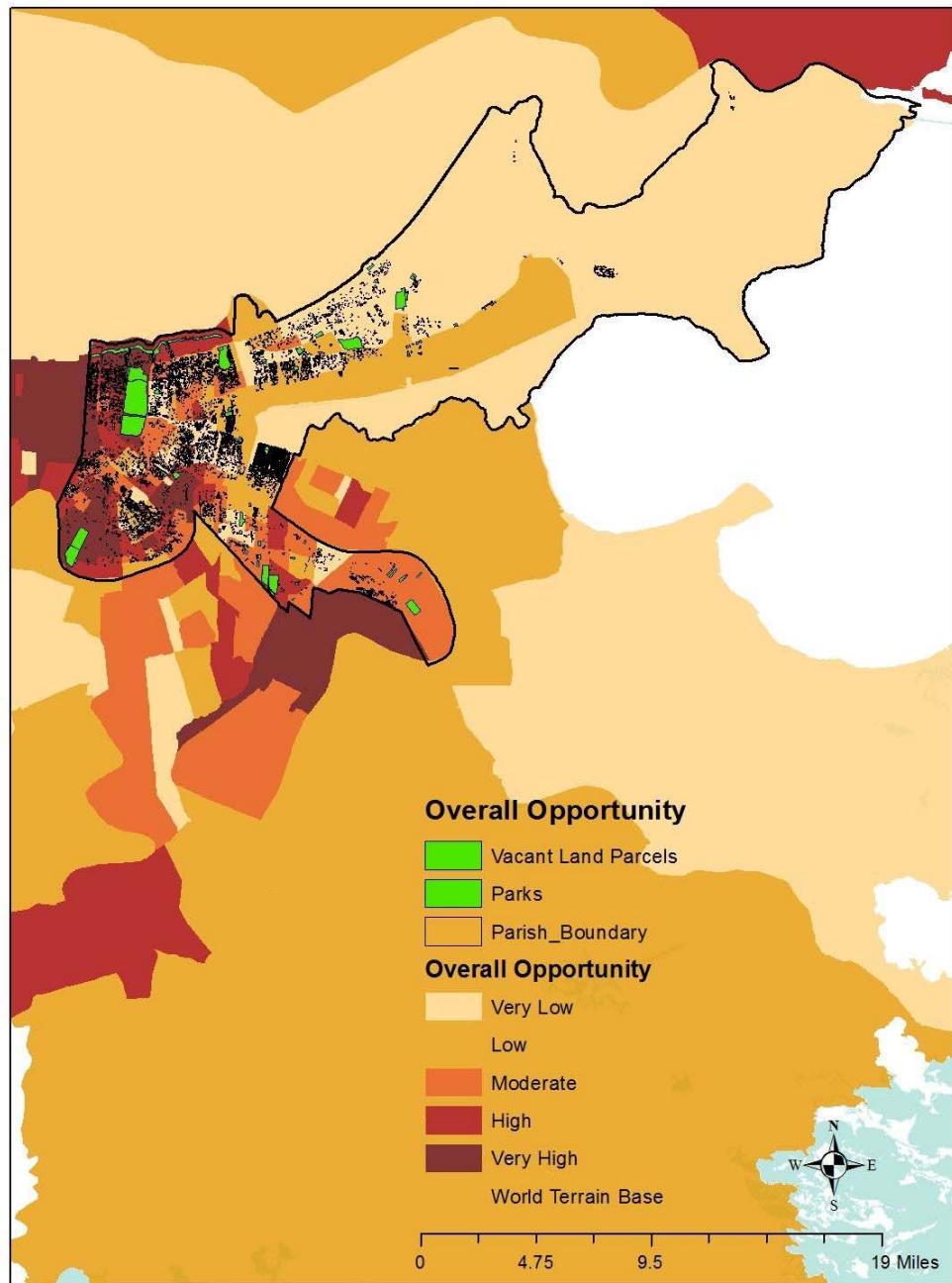


Figure 28: Overall Opportunity from Kirwan Institute

Based upon the Kirwan Institute opportunity map for overall opportunity (Figure 28), fourteen percent of publicly owned vacant land parcels in New

Orleans are found within optimum habitat, sixteen percent within suboptimum habitat, and seventy percent within marginal habitat.

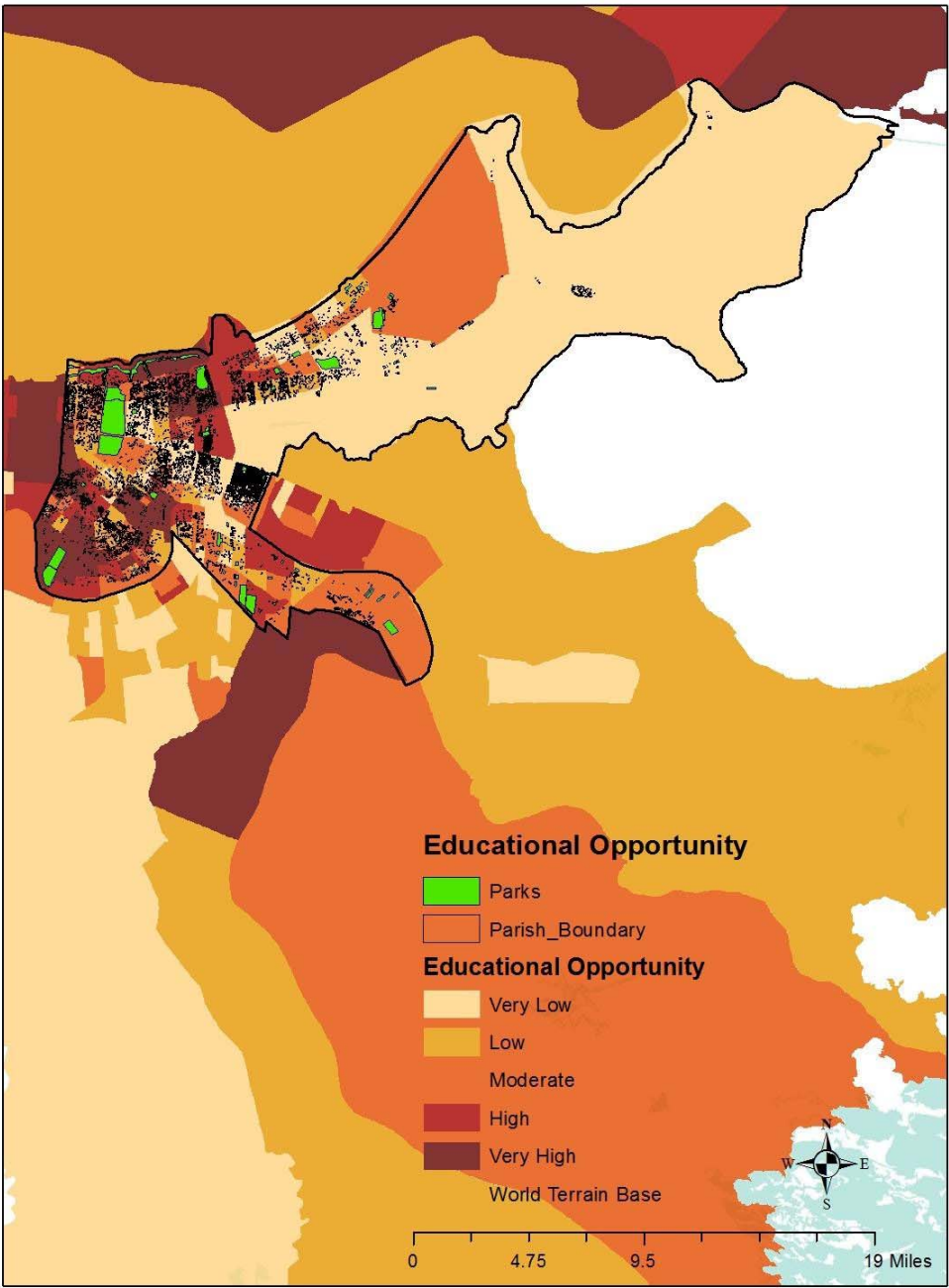


Figure 29: Educational Opportunity from Kirwan Institute

The Kirwan Institute map for educational opportunity (Figure 29) demonstrated that twenty-three percent of all publicly owned vacant land parcels in New Orleans lay within areas considered optimum habitat, eighteen percent within suboptimum habitat, and fifty-eight percent marginal habitat.

Social and economic opportunity as illustrated by the Kirwan Institute map (Figure 30), demonstrated nineteen percent of publicly owned vacant land

in New Orleans lies within optimum habitat, sixteen percent within suboptimum habitat, and sixty-five percent within marginal habitat.

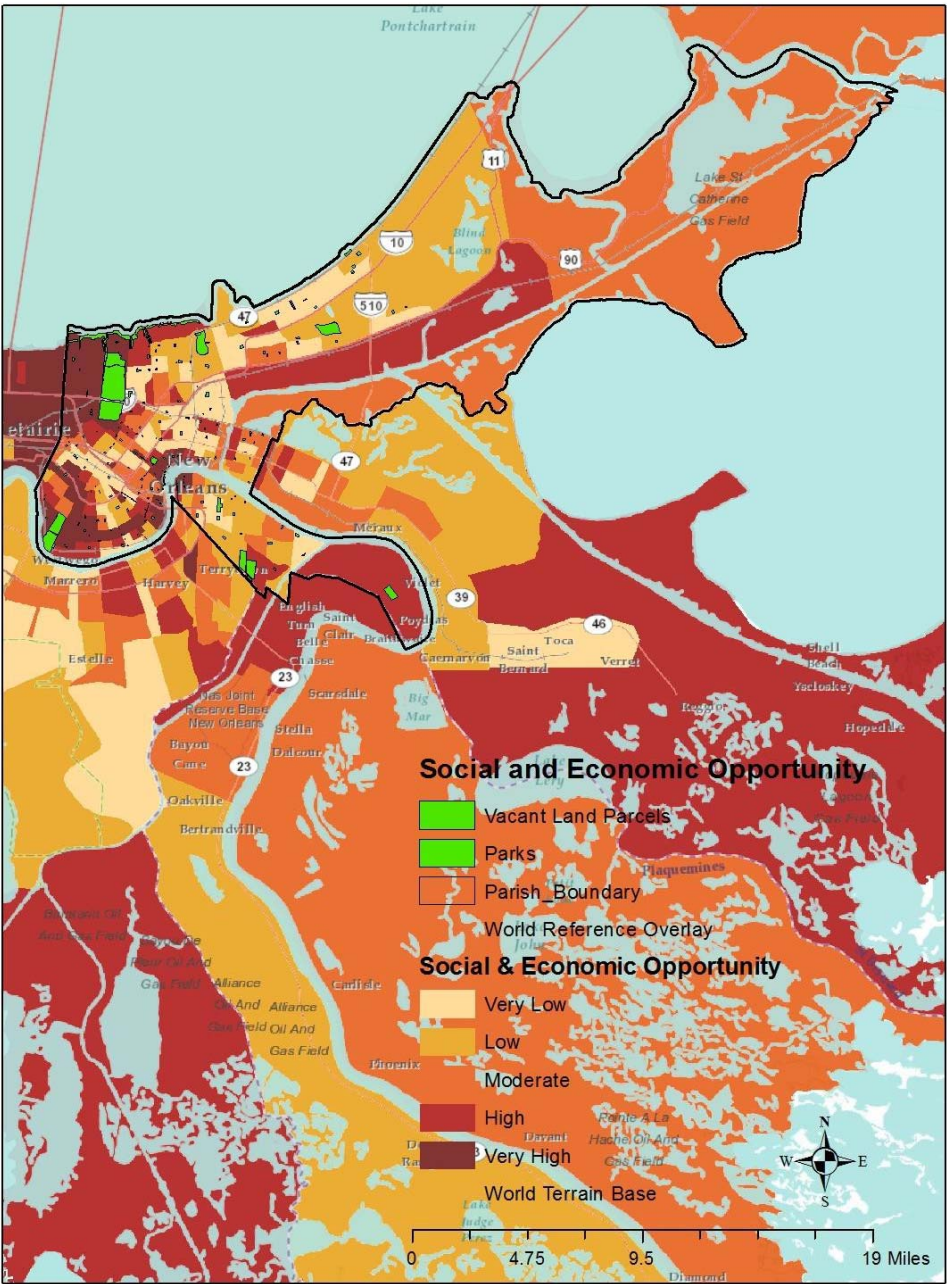


Figure 30: Social and Economic Opportunity from Kirwan Institute

The Kirwan Institute map for health and environmental opportunity (Figure 31) demonstrated that 12 percent of publicly owned vacant land parcels



in New Orleans lie within optimum habitat, 10 percent within suboptimum habitat, and 78 percent within marginal habitat.

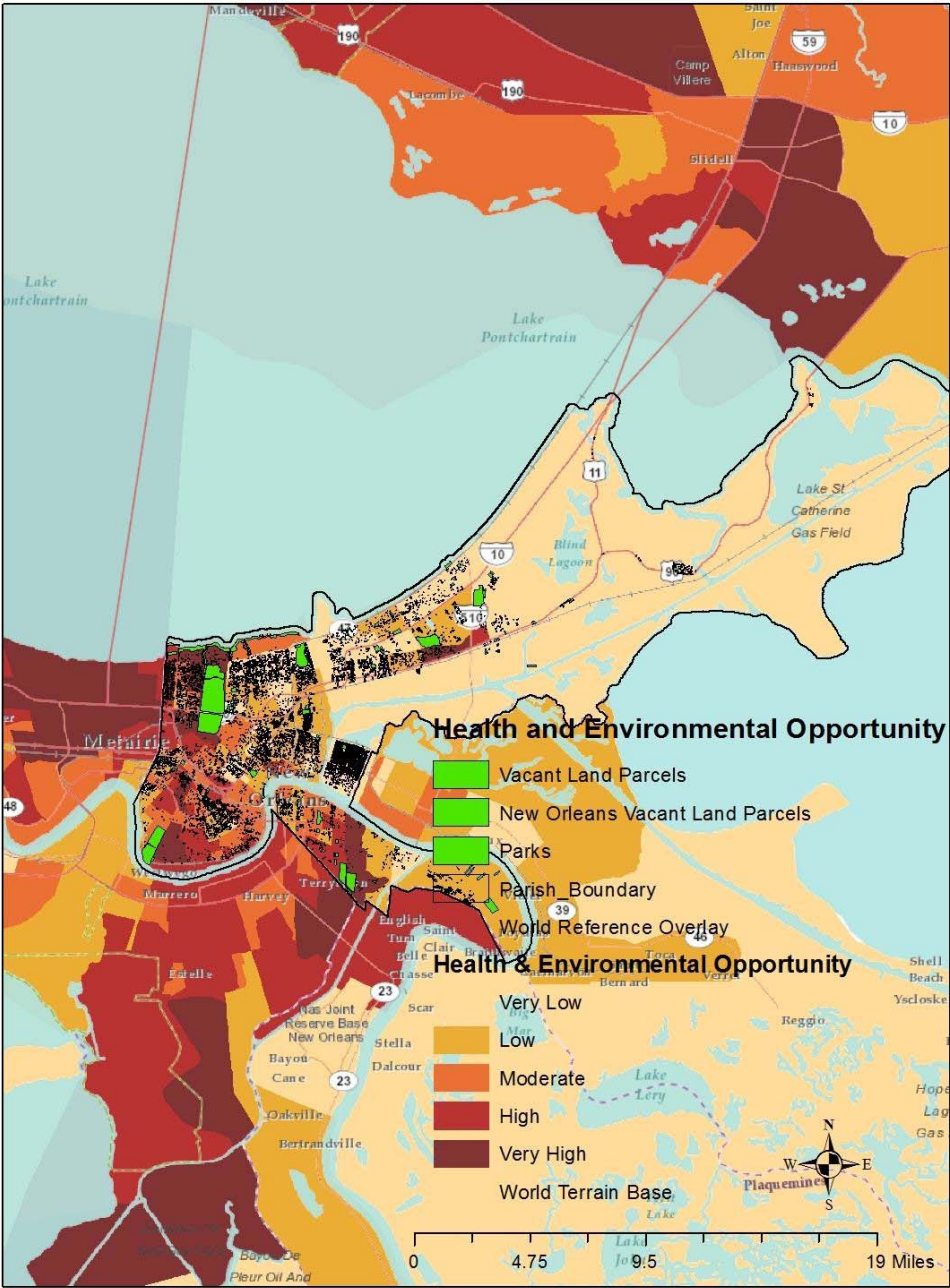


Figure 31: Health and Environmental Opportunity from Kirwan Institute

This comparison of the Kirwan opportunity maps and the location of publicly owned vacant land parcels in New Orleans demonstrated a strong relationship between proximity to opportunity and occupancy and between the absence of opportunity and vacancy. This supported the premise of the habitat quality model that high quality (optimum) habitat supports occupancy and poor quality (marginal) habitat vacancy.

#### **6.1.4.1 Proximity to Employment**

Proximity to employment in New Orleans as measured by travel time in minutes to employment (Figure 32) was shown to be less of an indicator of publicly owned vacant lands than proximity to the various components of opportunity as illustrated by the Kirwan Institute opportunity maps. Thirty-two percent of publicly owned vacant land parcels in New Orleans lie within optimum habitat (shortest commute), 44 percent within suboptimum habitat, and 25 percent within marginal habitat.

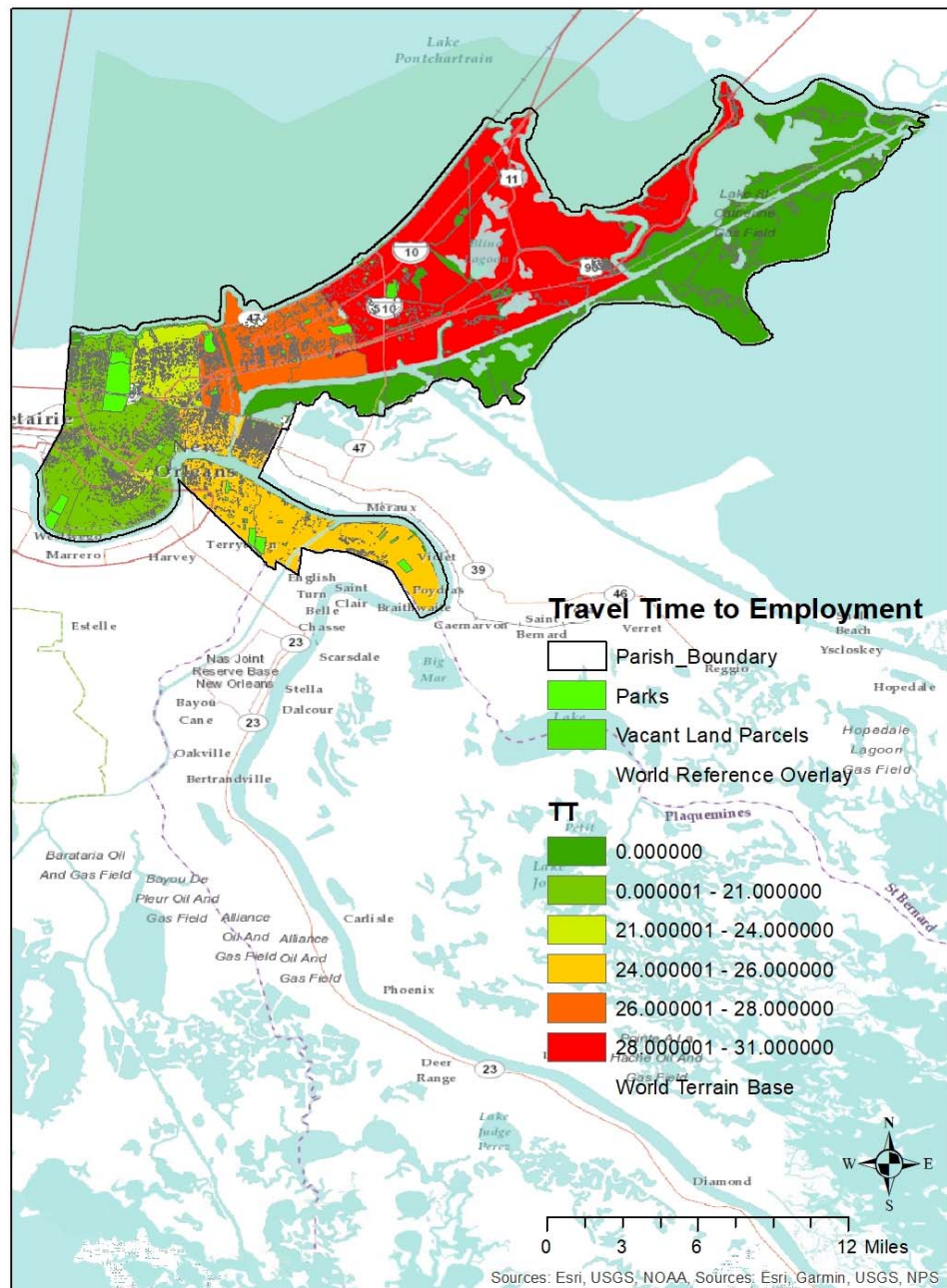


Figure 32: Travel Time to Employment

This generally suggests an inverse relationship between proximity to employment and land vacancy made possible by the greater mobility of higher income households. One might also theorize that because publicly owned vacant land parcels

are found in proximity to industrial areas, the travel time to employment for individuals within these areas is relatively short.

#### **6.1.1.1 Proximity to Transportation**

It was anticipated that proximity to transportation, including rail or streetcar transit, automobile access, and air access influence habitat quality. Commute time to employment and the negative impact of pollution were considered as part of the mapping of factors available from the EPA EJScreen. Further examination of the benefits and impact of transportation, particularly light rail and streetcar on habitat quality was warranted but beyond the scope of this study.

#### **6.1.1.2 Proximity to Education**

Information on the location of schools in New Orleans is available as a GIS shapefile. However, information on the relative quality of schools in New Orleans is not available, so assessing the relative proximity to quality education was not possible with available data. The Kirwan Institute opportunity mapping did factor in educational quality and this information was utilized as a measure of educational quality.

#### **6.1.4.3 Access to Information Technology**

Data available from PolicyMap suggests that internet access in New Orleans is ubiquitous. It is likely that cable or fiber exists to every home within the city. However, market penetration of these services likely vary according to one's ability to pay. Spatial data illustrating the market penetration of internet service was unavailable.

#### **6.1.4.4 Proximity to Energy**

Energy is one of the nutrients essential to life and the functioning of a city. Modeling energy input into a city, however, was beyond the scope of this research. Energy flows could be examined spatially by considering the location of powerlines



and gas transmission pipelines. A review of national GIS mapping data available from ESRI indicates that there are no major powerlines or pipelines within the City of New Orleans or that available data is not at sufficient scale to indicate the location of such lines. Electrical service is believed to be ubiquitous and available to all residents, though access may vary according to one's ability to pay.

#### **6.1.4.5 Proximity to Food Supply**

Access to quality food supplies as mapped by the United State Department of Agriculture data demonstrated a strong relationship with vacancy (Figure 33). None of the vacant land parcels in New Orleans were found in census tracts with close proximity to grocery stores (optimum habitat) based upon this measure. Thirty-nine percent were in census tracts in the middle third of access to grocery stores (suboptimum habitat), and sixty-one percent in census tracts with poor access to grocery stores (marginal habitat). These areas are considered food deserts by the United States Department of Agriculture.

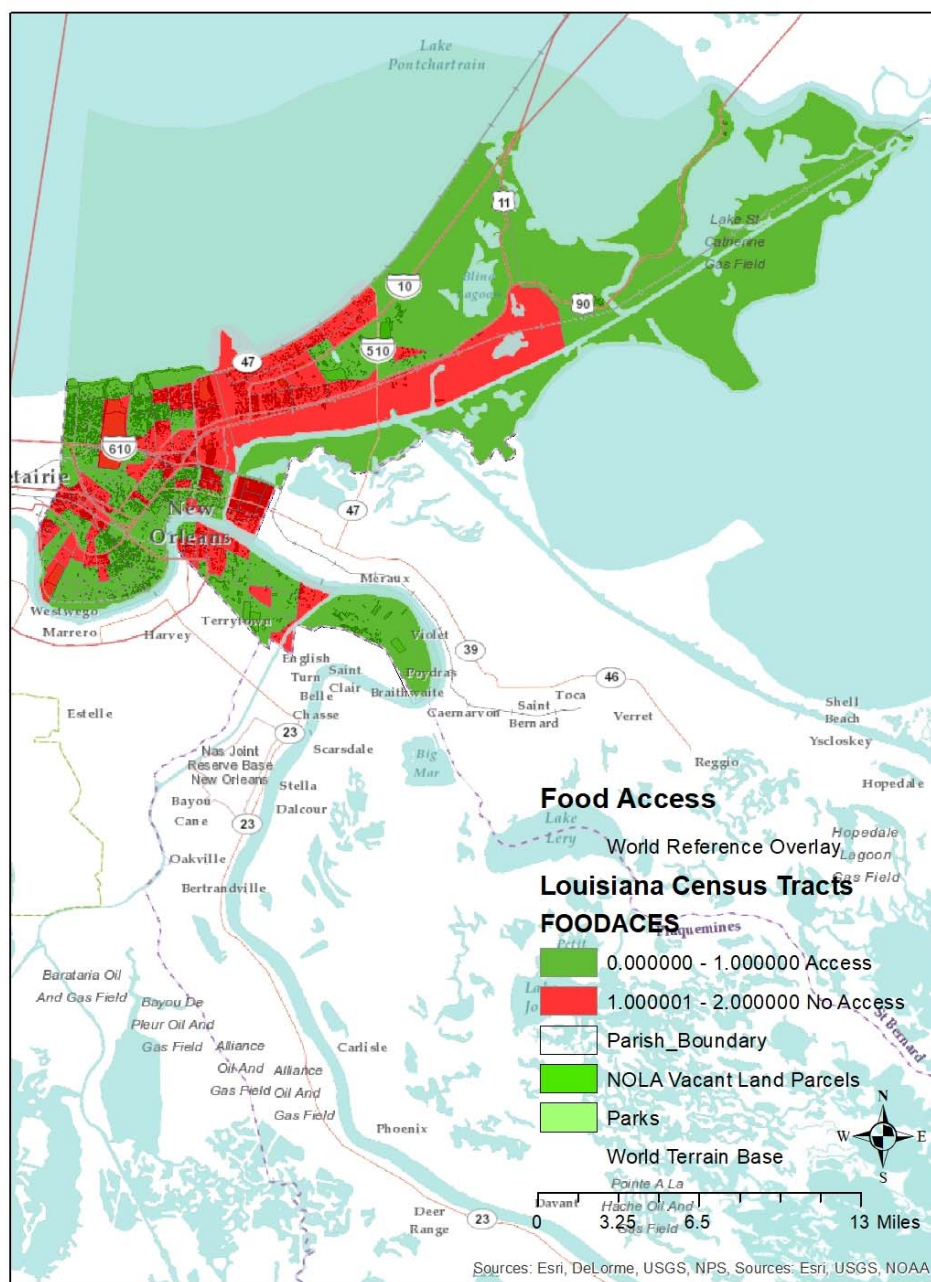


Figure 33: Proximity to Quality Food Supply

#### **6.1.4.7 Proximity to Goods and Services**

Typically, grocery stores serve as an anchor tenant in shopping centers so that areas that are underserved by food supplies are also underserved by other forms of retail. Habitat quality mapping based upon proximity to food supply may, therefore, also indicate areas lacking in proximity to other goods and services.

#### **6.1.4.8 Proximity to Cultural Resources and Places of Worship**

Proximity to entertainment and other cultural resources such as museums, art galleries, and sports venues can also impact habitat quality. Places of worship can also impact habitat quality. The identification of the myriad cultural resources that influence habitat quality was beyond the scope of this study and not included in the habitat quality model.

#### **6.1.4.9 Proximity to Parks and Open Space**

The conversion of publicly owned vacant lands to parks, open space, or agricultural lands is often suggested as one means of addressing the challenge of vacant lands. The ParkScore system of the Trust for Public Land, which classifies areas of a city as served by parks, high need for parks, or very high need for parks, was consulted for the level of park access available to New Orleans residents (Figure 34). This comparison of the Trust for Public Land ParkScore mapping of New Orleans indicated that only small pockets of the city were classified as in high or very high need for parks with most of the city classified as served by parks. While additional park land may improve the quality of life of residents in areas with high land vacancy, this data demonstrated that an absence of parks was not a major contributing factor to vacancy.

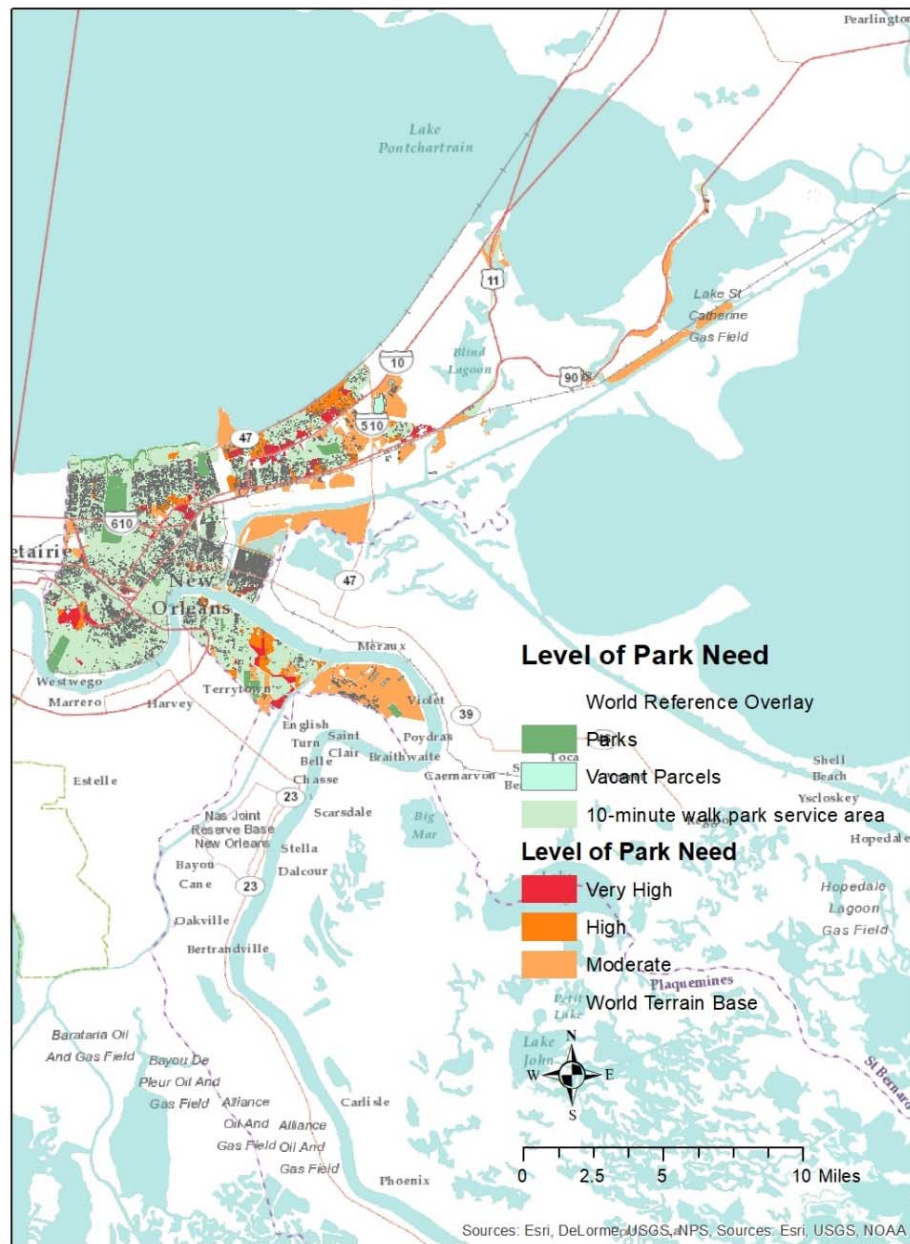


Figure 34: Level of Park Need and Vacancy

#### 6.1.6.10 Proximity to Views

Views have been proven to influence real estate prices and it could be reasoned habitat quality. In New Orleans views of the city skyline, the Mississippi

River, and Lake Pontchartrain may influence land vacancy. However, this factor was not considered in this research due to a lack of resources.

Views of the Mississippi River, Lake Pontchartrain, beautiful street such as St. Charles and the grand architecture that lines the corridor, as well as, the famous parks of the city such as Jackson Square and Audubon Park are often referenced in the tourist literature and no doubt impact residential location decision making in the city. Well-designed areas of New Orleans may or may not have less vacancy than other areas of the city, but an analysis of this factor was beyond the scope in this research.

#### **6.1.4.11 The Value of Urban Design**

As a city of historic architecture and parks, New Orleans is often used as one of the models of historic urbanism that inspired the New Urbanist movement in the United States. A detailed evaluation of the impact of urban design in the city on publicly owned land vacancy was not possible given available resources.

#### **6.1.5 Geophysical Risk**

Four factors of geophysical risk were considered in assessing publicly owned vacant land in the City of New Orleans: subsidence, sea level rise, wetlands, and flooding. A significant consideration of the disturbance regime of New Orleans is the frequency and impact of hurricanes. Unfortunately, modeling techniques do not exist to predict the path and magnitude of future hurricanes. Mapping of sea level rise and flooding provide some indication of the potential damage wrought by rising water, but no technique was available for this research to model wind damage. One might hypothesize that older homes and buildings, built before current building codes are more subject to wind damage than more recent construction but the mapping of buildings by age was beyond the scope of this research effort.

By averaging the percentage of publicly owned vacant land parcels based upon the impact of subsidence, sea level rise, wetlands, and flooding, it was found that twenty-one percent of vacant land parcels are found in optimum habitat, thirty-

one percent in suboptimum habitat, and forty-nine percent in marginal habitat. The challenge in such an analysis was the impact of manmade levees and the pumping system of the city. Over the city's history, the levee systems of New Orleans have always failed. Levee breaches which led to the flooding following Hurricane Katrina of the Lakeview neighborhood in New Orleans, an area of higher income population that is historically not susceptible to flooding increased the city's inventory of publicly owned vacant lands. But they have worked for a period of time providing some assurance that residents are safe and that land is suitable for habitation. Without such a system of protection roughly eighty percent of the City of New Orleans would be considered marginal habitat.

#### **6.1.5.1 Soils, Geology and Vacancy**

The geologic conditions of New Orleans are defined primarily by the natural levees of the Mississippi River and Bayou Metairie and Bayou Sauvage which define the high land of the city. Topography is a major consideration in the quality of habitat in the city because it determines lands subject to flooding. New Orleans is subject to subsidence, but earthquakes, collapsible soils, and other geologic conditions are not a determinant of habitat quality (Figure 32).

#### **6.1.5.2 Pre-settlement Vegetation and Vacancy**

No old growth forest remains within the city limit boundaries today. While the quality of the tree canopy of the city no doubt contributes to habitat quality, this research did not demonstrate a relationship between pre-settlement vegetation and publicly owned land vacancy.

#### **6.1.5.3 Topography, Slope, and Vacancy**

The site of the City of New Orleans is virtually flat with only ten feet of grade change across the entire city except for manmade earthworks like levees. Topography or slope was not, therefore, found to be a means of differentiating habitat quality.

Elevation, as discussed later in this chapter was a significant consideration in defining habitat quality.

#### **6.1.5.4 Subsidence and Vacancy**

Were it not enough that much of New Orleans lies below sea level and within the 100-year floodplain, the city is gradually subsiding. Areas around major industrial areas are sinking up to 2 inches (50 millimeters) a year (Figure 35). Researchers at the Jet Propulsion Laboratory also identified significant subsidence in the Upper and Lower Ninth Ward, neighborhoods, areas not only close to the industrial pollution of the Industrial Canal, but also subject to major flooding. Conversations with these researchers suggested that there are multiple causes for this subsidence including groundwater pumping by industrial users, but also decomposition and compaction of the former swamp and marsh lands on which many of these neighborhoods were constructed.



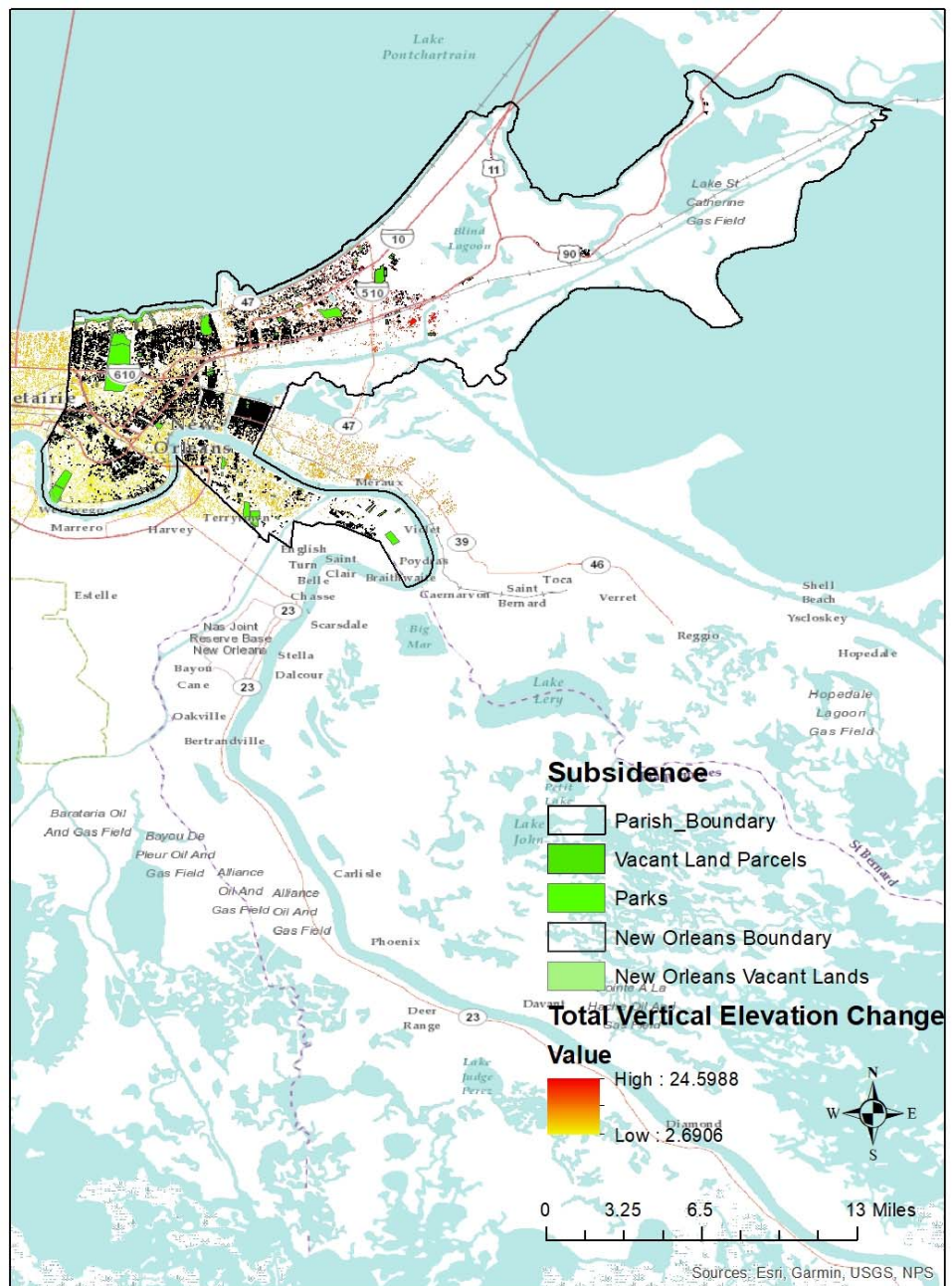


Figure 35: Subsidence in New Orleans

### 6.1.5.3 Flooding and Vacancy

As a city ravaged by flood many times during its history, New Orleans is very sensitive to rising water, particularly when driven by hurricane force winds.



The Federal Emergency Management Agency has mapped flood zones for the city both defining areas subject to the 100-year flood (marginal) and the 500-year flood zone (optimum) (Figure 36). One can debate whether construction of housing and other high occupancy structures should be allowed within the 100-year floodplain, as this zone has commonly been flooded during the city's history. A strong argument can be made that these zones would have been better left as open space as the city developed. Flooding often leads to loss of employment as places of employment are damaged, loss of private property which makes the accumulation of financial assets difficult, loss of health, and loss of life. Standing water can lead to disease. The inability to accumulate wealth due to loss during disaster reduces the economic resilience of residents and perpetuates poverty.

Those areas which would only be flooded during the 500-year flood – the areas comprised by the natural levels of the Mississippi and Bayou Metairie and Bayou Gentilly (Sauvage) appear to be reasonable sites for development. These are the lands that the first settlers occupied as they apparently considered these lands to be optimum habitat. It was only after the creation of the Woods pump in the 1920s that the city spread onto marginal lands – the swamp and marsh lands that are often flooded.

Eight percent of all vacant land parcels are found in areas within the 500-year floodplain, considered optimum habitat. Thirty-one percent of publicly owned vacant land parcels lie within suboptimum habitat, though in New Orleans this was classified as lands one to three feet above sea level. One could hypothesize that these are easily subject to storm surge and are in fact marginal habitat. Sixty-one percent of all publicly owned vacant land parcels in New Orleans lie at or below sea level, areas considered marginal habitat.

Levees and pumps are an adaptive evolutionary strategy. Flood insurance rates set by the Federal Emergency Management Agency assume that these adaptive systems will succeed and protect the city. Yet over the course of the city's history

these systems have worked for a period, only to eventually fail.

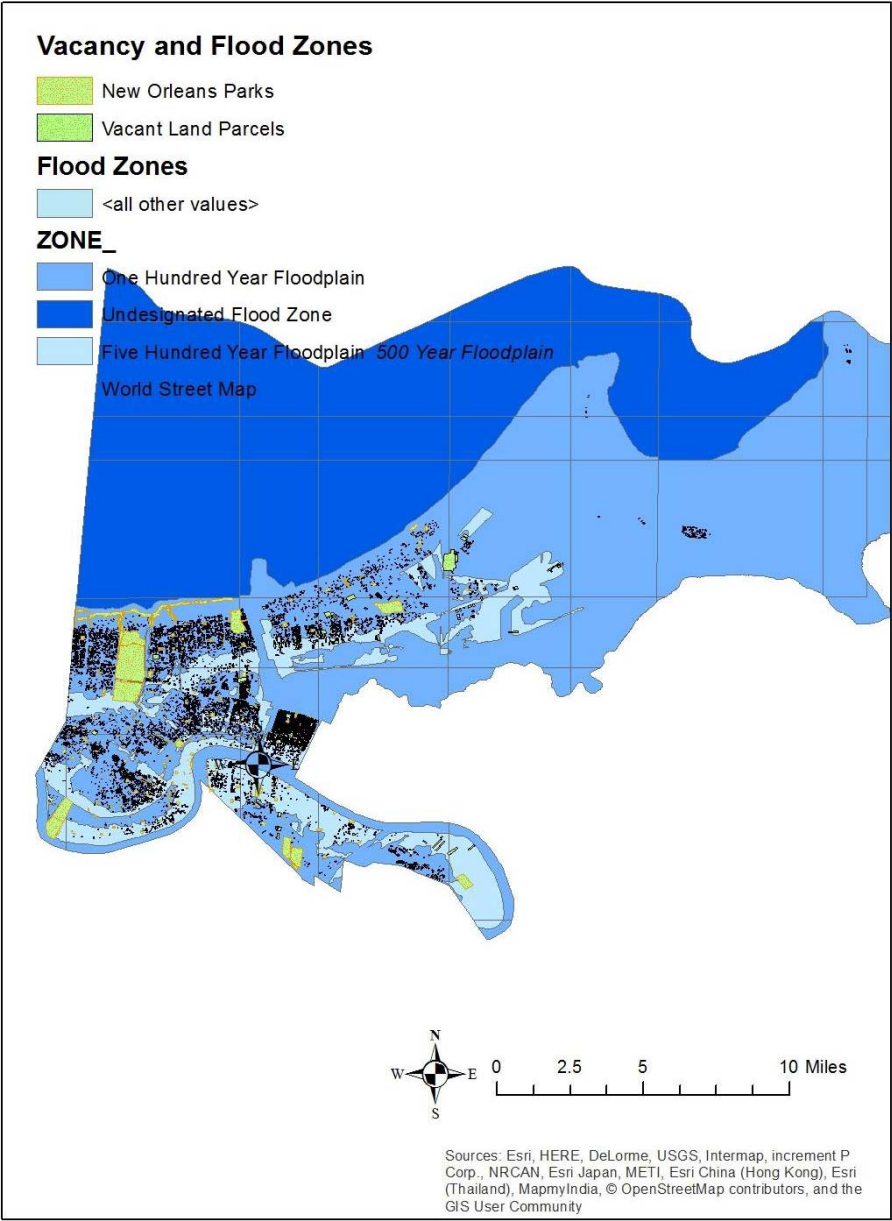
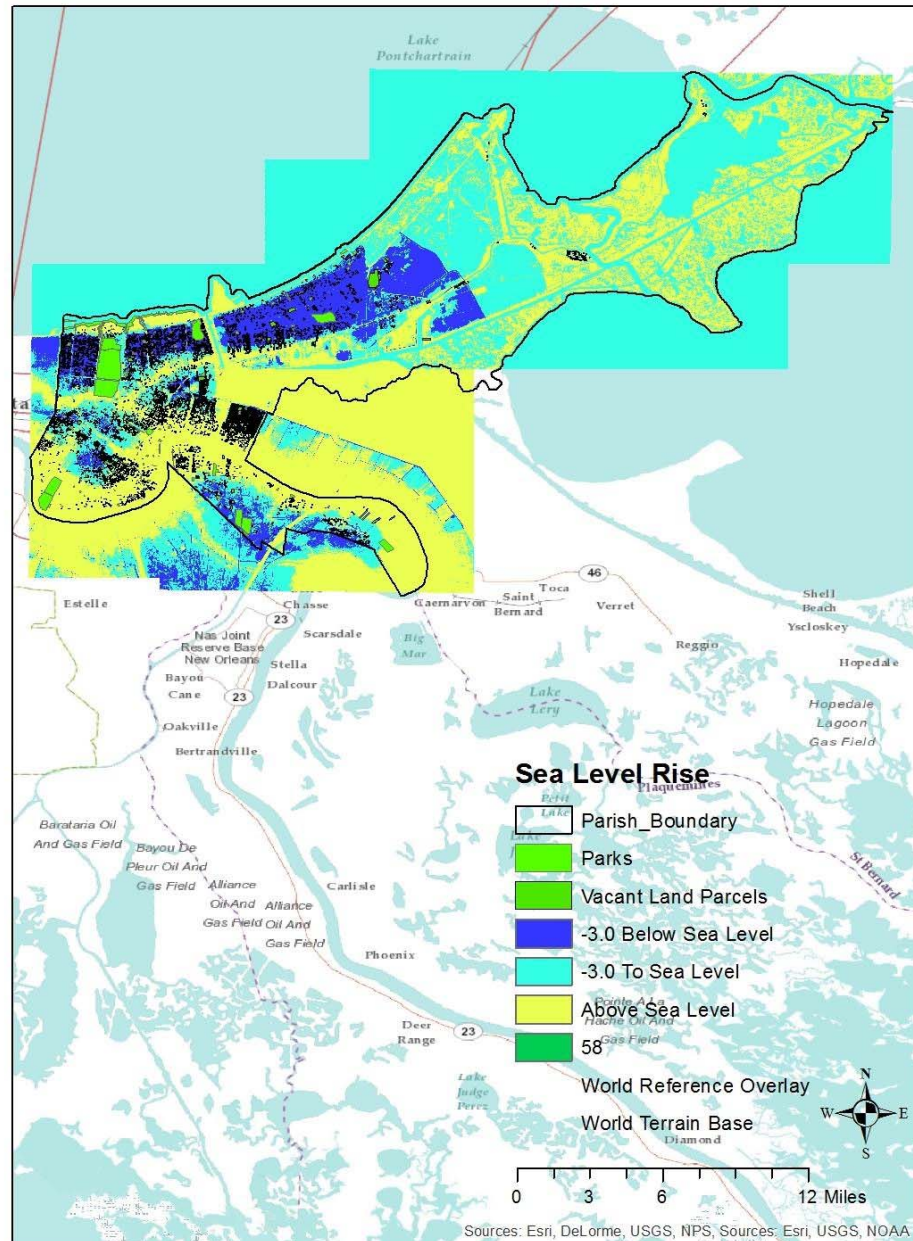


Figure 36: Flood Zones and Vacancy in New Orleans

#### 6.1.5.4 Sea Level Rise

Only seven percent of publicly owned vacant land parcels in New Orleans were located above sea level (optimum habitat) (Figure 37). Fifty-one percent were located from 0 to three feet below sea level (suboptimum habitat), and forty-two percent more than three feet below sea level (marginal habitat). Without the



protection of levees, this suboptimum habitat would reasonably be considered marginal as well.

Figure 37: Vacancy and Sea Level Rise

#### **6.1.5.5 Hurricanes and Vacancy**

Hurricanes have been part of the disturbance regime of New Orleans from the recorded history of the city, and Hurricane Katrina certainly contributed to the current land vacancy in the city. However, modeling techniques did not provide a method to predict the impacts of future hurricane on the city or to differentiate habitat quality.

#### **6.1.6 Social Risk**

##### **6.1.6.1 Social Vulnerability and Vacancy**

The Agency for Toxic Substances and Disease Registry (ATSDR) Social Vulnerability Index ranks each census tract on fourteen social factors. These factors were grouped into four themes: Socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. A map layer of vacant land parcels in New Orleans was overlay over map layers for each of these themes. Eighteen percent of publicly owned vacant land parcels were within optimum habitat based upon socio-economic factors, thirteen in suboptimum, and sixty-nine percent in marginal habitat (Figure 38).

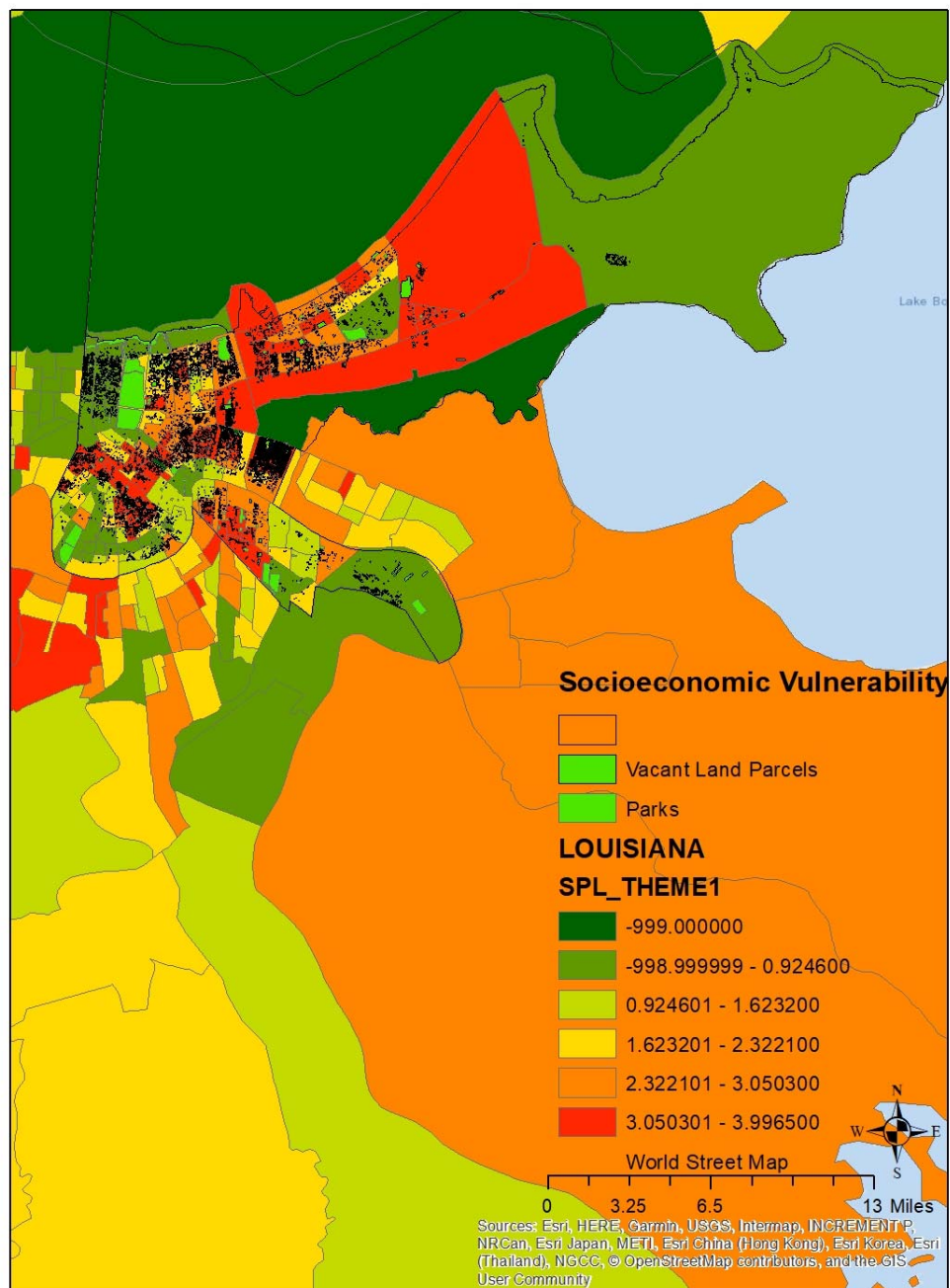


Figure 38: Socioeconomic Status and Vulnerability in New Orleans



Based upon household composition and diversity, thirty-three percent were within optimum habitat, twenty-one percent within suboptimum, and forty-nine percent in marginal habitat (Figure 39).

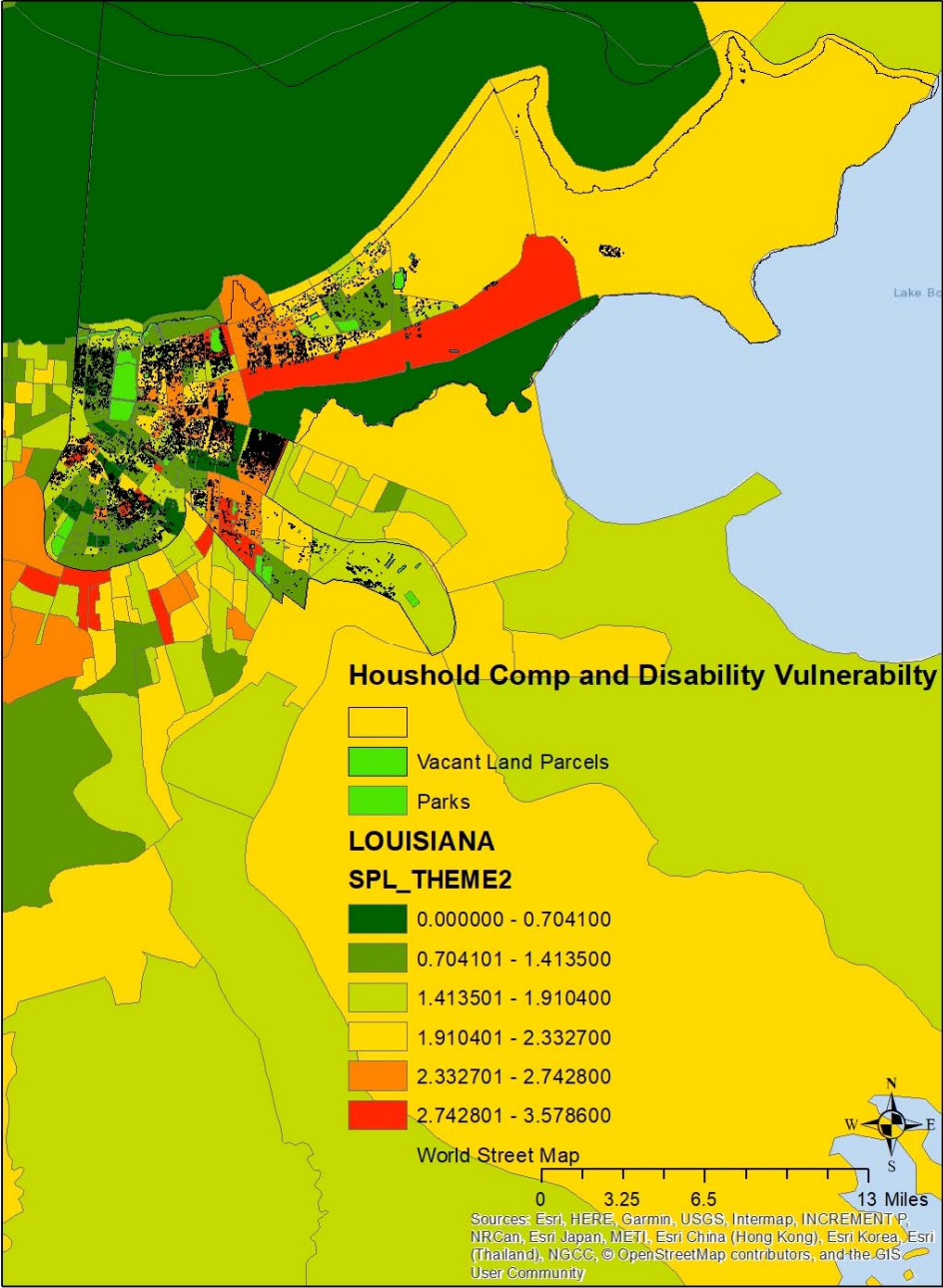


Figure 39: Household Composition and Disability Vulnerability in New Orleans

A review of the map layer for minority population and language found that thirteen percent of publicly owned vacant land parcels were within optimum habitat, thirty-one percent within suboptimum habitat, and fifty-six percent within marginal habitat (Figure 40).

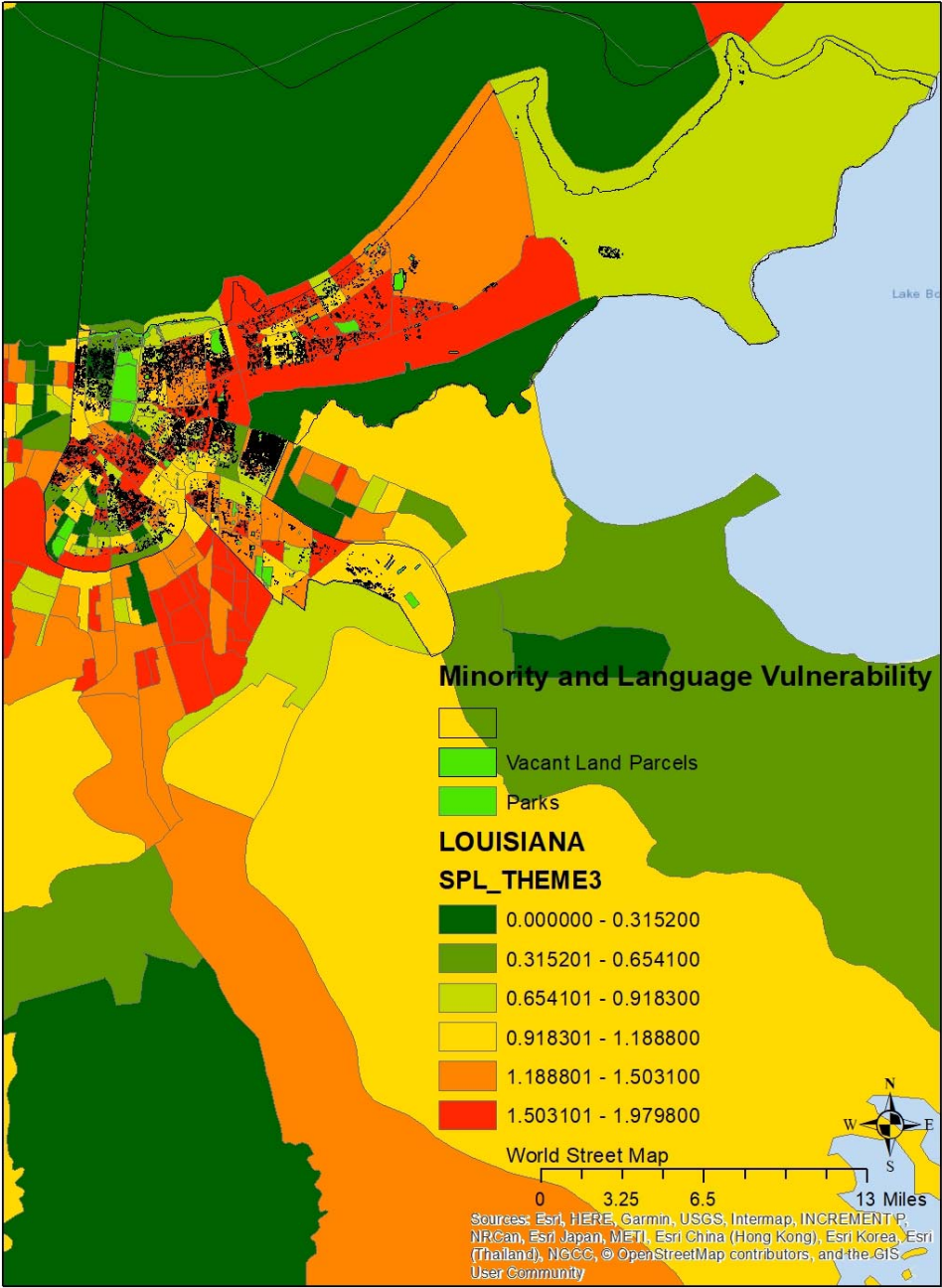


Figure 40: Minority Status and Language Vulnerability in New Orleans

The map layer for housing and transportation (Figure 41), demonstrated that forty-five percent of publicly owned vacant land parcels were within optimum habitat, thirteen percent within suboptimum, and forty-three percent within marginal habitat.

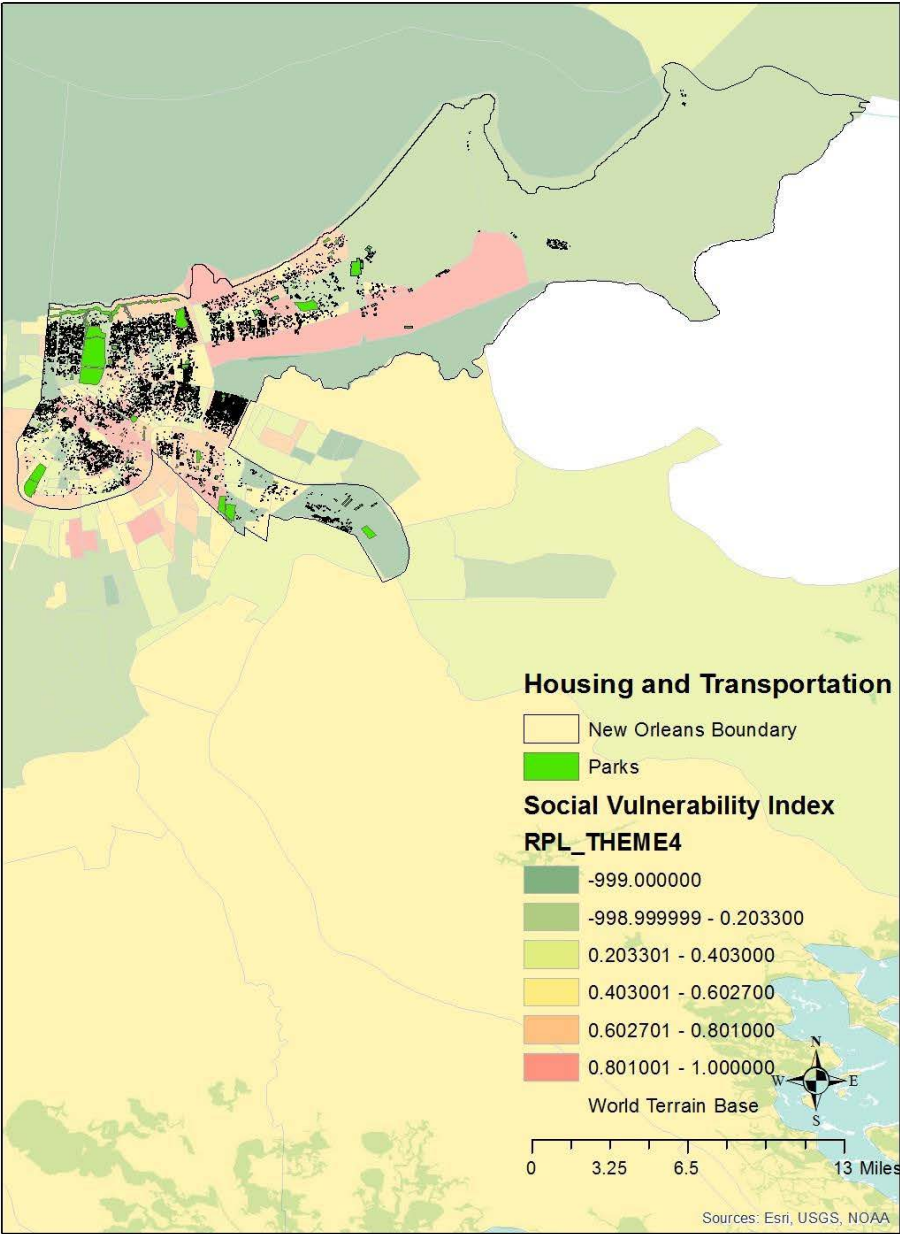


Figure 41: Housing and Transportation Vulnerability



#### **6.1.6.2 Race and Vacancy**

Although race is not a risk, land vacancy is highly related to land vacancy. In New Orleans, thirty-one percent of vacant land parcels are in the third of census tracts with the smallest percentage of African-American population, sixteen percent within those census tracts with an intermediate percentage of African-American population, and fifty-three percent are in those census tracts with the highest percent of African-American population (Figure 42).

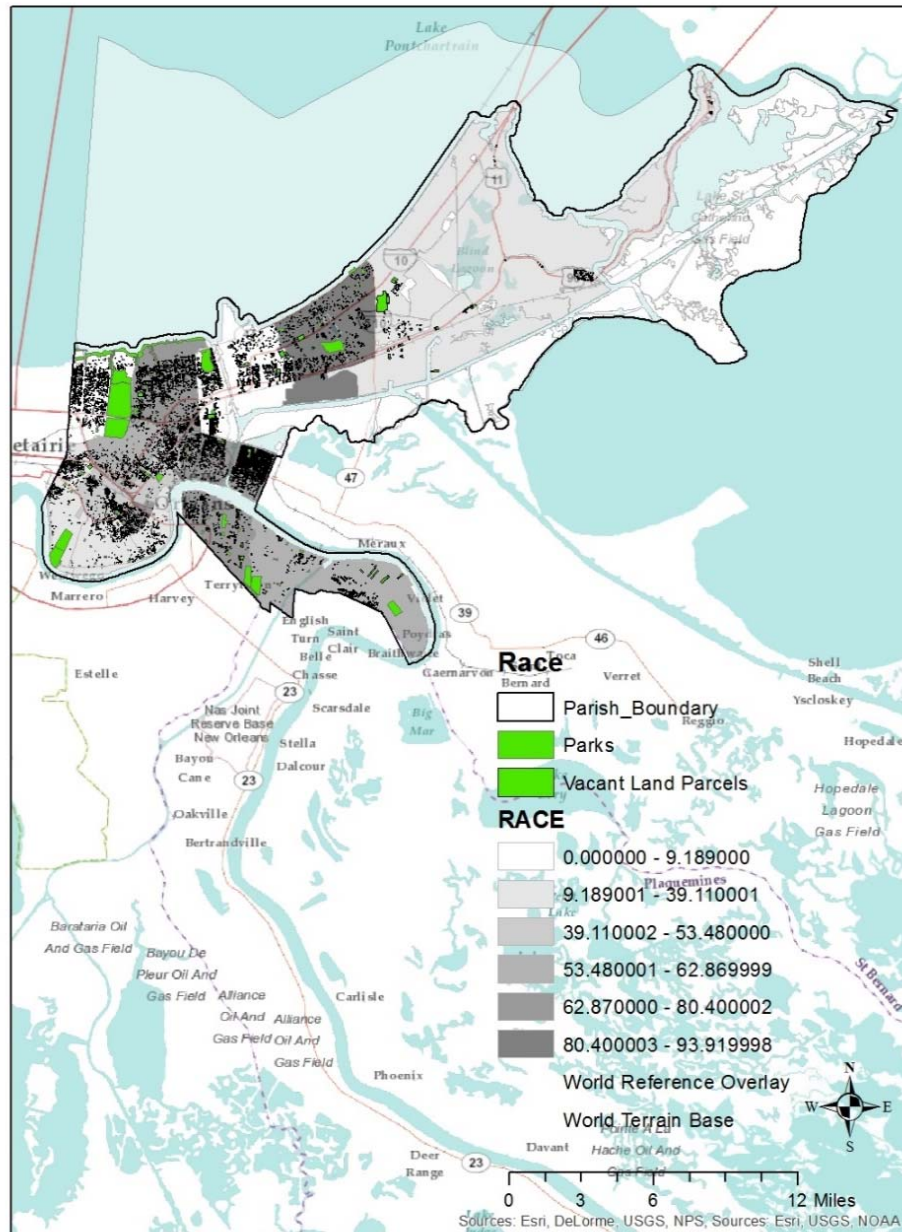


Figure 42: Percentage of African American Population and Vacancy

### 6.1.6.3 The Diversity Index and Vacancy

Seventy-six percent of the publicly owned vacant land parcels in New Orleans are in marginal habitat based upon the Thiel Index. Twenty-

one percent are in suboptimum habitat and three percent are in optimum habitat (Figure 43).

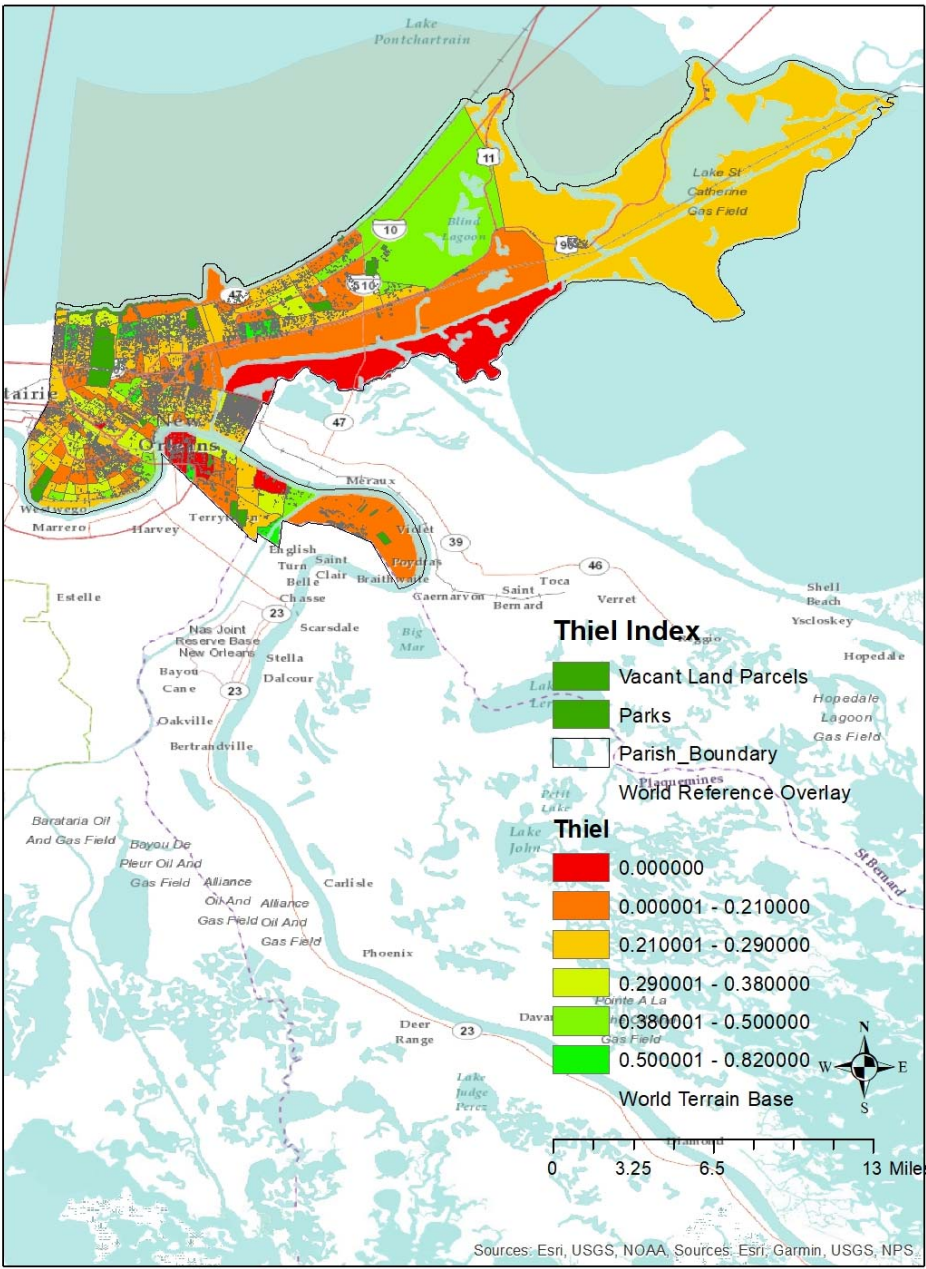


Figure 43: Diversity Index and Vacancy in New Orleans

6.1.6.4 Racial Covenants and Vacancy

Histories of the city of New Orleans suggests that racial covenants were utilized as they were in other American cities in the early decades of the 20<sup>th</sup> century. There is, however, no comprehensive database or map of where such covenants were utilized in the city. Ironically, the exclusively African-American neighborhoods that resulted from this policy sometimes provided strong examples of the positive impact of social capital. An excellent example of this impact on neighborhood effects is the Pontchartrain Park neighborhood, a neighborhood first created in 1951 specifically for African-Americans when other developments excluded African-Americans (*Times-Picayune*, 2011). Despite abutting the Industrial Canal and being severely damaged by Hurricane Katrina, the Pontchartrain Park neighborhood possesses a higher level of educational attainment, higher household incomes, and lower vacancies than other neighborhoods that border the Industrial Canal. The presence of a high level of social capital has contributed to the neighborhood's resilience.

#### **6.1.6.5 Redlining and Vacancy**

Sixty-two percent of the publicly owned land parcels in New Orleans were located in marginal habitat based upon redlining. Twenty-eight percent was in suboptimum habitat, and ten percent in optimum habitat.

#### **6.1.6.6 Urban Renewal and Vacancy**

Although urban renewal in New Orleans was known to exist, particularly in conjunction with land clearance for the construction of Interstate 10 in the city, publicly owned land vacancy directly related to that construction was not possible to isolate for the purpose of this analysis.

#### **6.1.6.7 Public Housing and Vacancy**

Although many public housing projects were constructed for minority and low income residents of New Orleans, these projects have been remarkably enduring

and only now are being cleared and redeveloped to provide new housing for residents of these projects. Unlike the Pruitt-Igoe project in St. Louis, which was imploded, the site of which remains vacant to this day, the impact of public housing projects in New Orleans on publicly owned land vacancy was not possible to isolate.

#### **6.1.6.8 Neighborhood Effects and Vacancy**

Crime, poverty, and other neighborhood characteristics all contribute to neighborhood effects. Because data was gathered for each of these individual factors a separate measure of neighborhood effects was not generated.

#### **6.1.6.9 Median Household Income and Vacancy**

For land to remain vacant, the market for the property must be weak. Fourteen percent of publicly owned vacant land parcels in New Orleans are found in the census tracts with the highest median household incomes in dollars as shown on the map below (Figure 44). Fifty percent are in census tracts in the middle third of median household incomes. Thirty-six percent are in the census tracts in the lowest third of median household incomes.

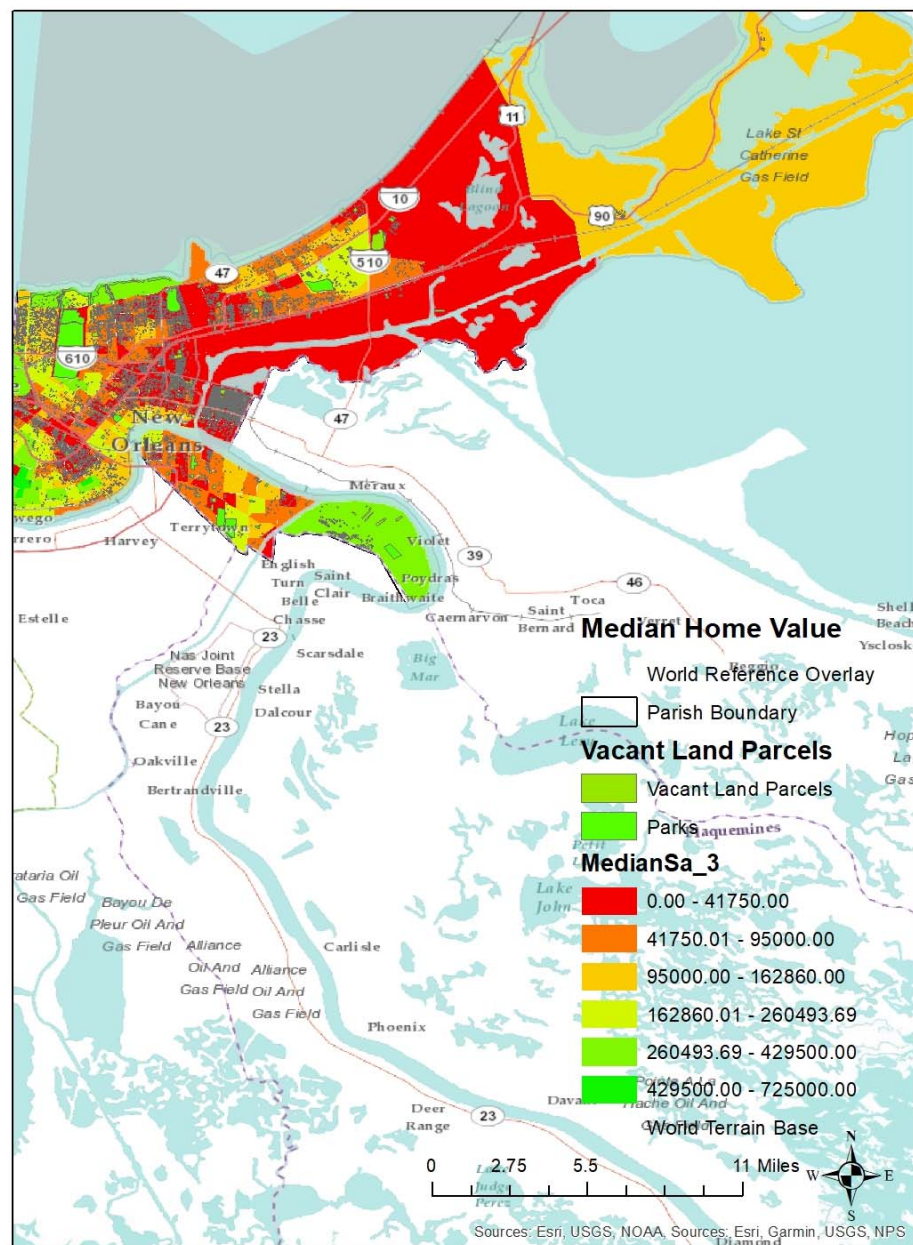


Figure 44: Median Household Income and Vacancy



### 6.1.6.10 Poverty and Vacancy

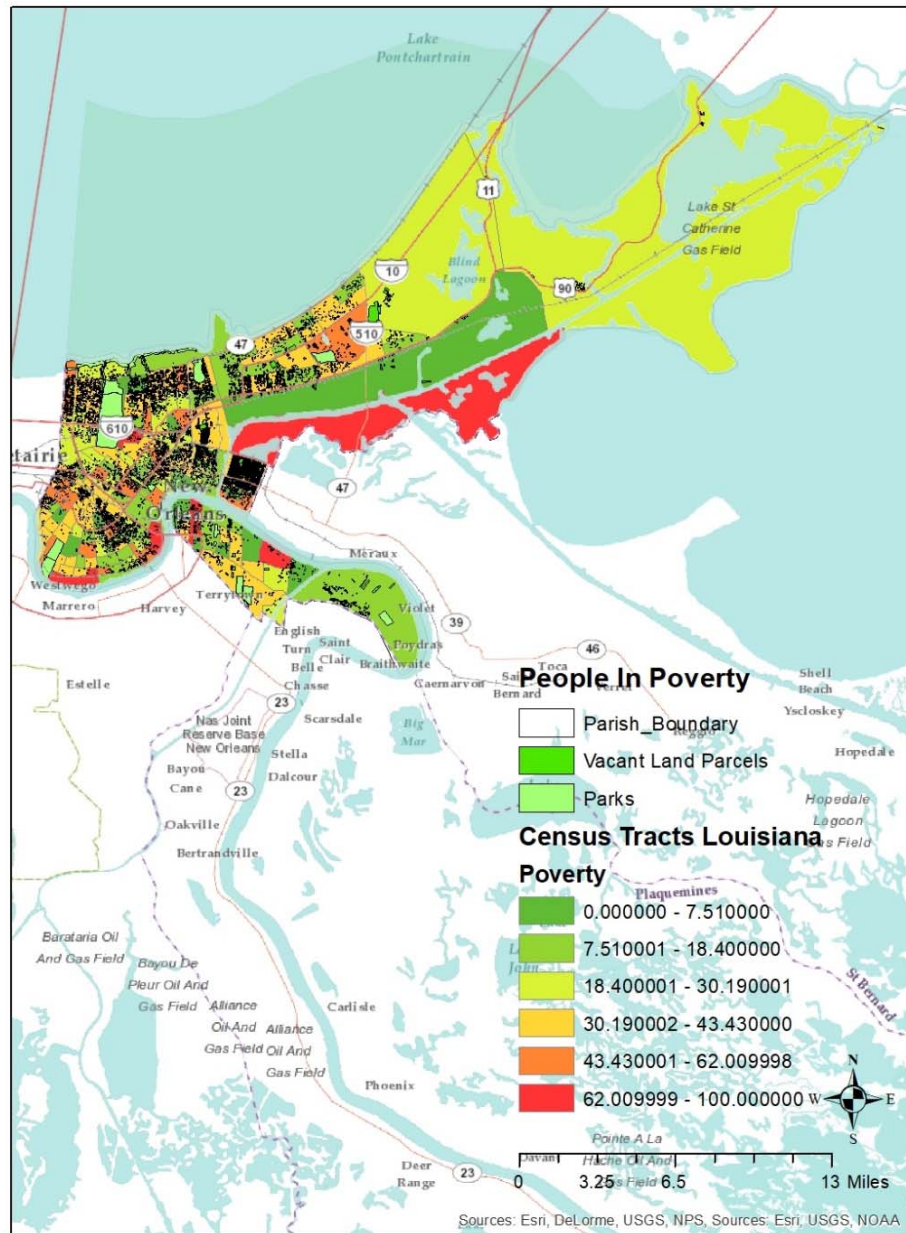


Figure 45: People Living in Poverty and Vacancy

Publicly owned vacant lands are highly related to poverty (Figure 45). Twenty-four percent of publicly owned vacant land parcels are in those census tracts with the lowest percentage of people living below the poverty level. Sixty-three

percent are in those census tracts in the middle third of those with the people living below the poverty level. Thirteen percent are found in those census tracts with the highest percentage of people living below the poverty level.

#### **6.1.6.10 Unemployment and Vacancy**

Unemployment was not utilized as a factor in determining land vacancy in New Orleans, as other measures such as median household income, home tenure, and poverty were utilized.

#### **6.1.6.12 Home Tenure and Vacancy**

Only four percent of publicly owned vacant land parcels in New Orleans were in marginal habitat based upon home tenure, however, sixty-nine percent were in suboptimum habitat, and twenty-seven percent in optimum habitat.

#### **6.1.6.13 Crime and Vacancy**

Although crime data was available from ESRI Online for New Orleans, the format of the data did not allow a determination of the number of publicly owned vacant land parcels within each level of habitat quality. The map generated does provide for visual inspection which indicates that publicly owned vacant land parcels are found in high crime areas, but a precise calculation of the percent of units in each habitat type was not possible (Figure 46).



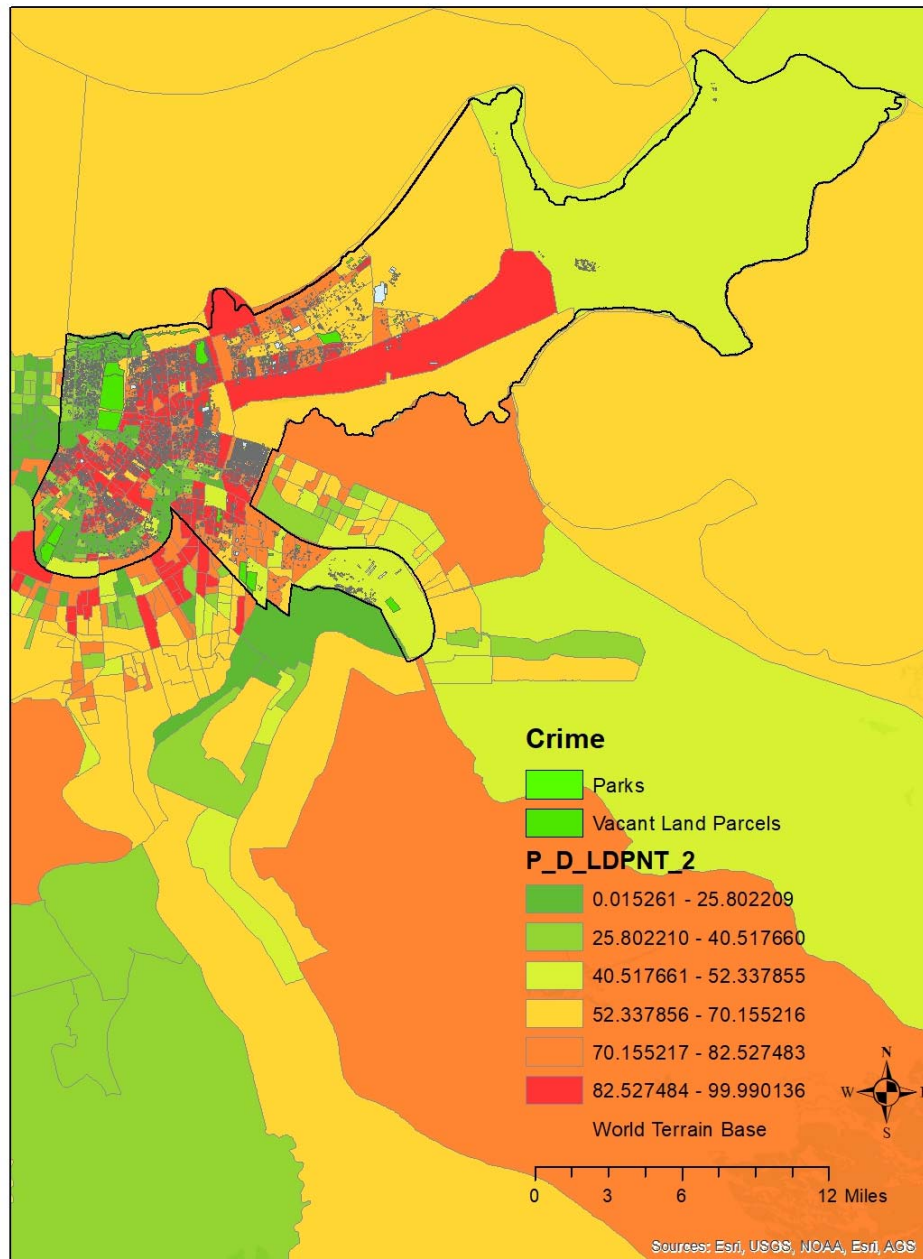


Figure 46: Crime and Vacancy in New Orleans

#### 6.1.6.14 Historic Districts and Vacancy

Of the 16,955 vacant land parcels in New Orleans, 3,467 (twenty percent) lie within designated historic districts. This number is considerable greater than in St.

Louis, however, New Orleans has designated thirty-two districts, increasing the likelihood that some neighborhoods which are economically disadvantaged have also received designation. Whether this suggests that historic districts typically encompass stable, healthy neighborhoods where residents have the social capital and interest to seek designation or whether the designation of historic districts stabilizes neighborhoods in flux has not been determined as part of this study (Figure 47).

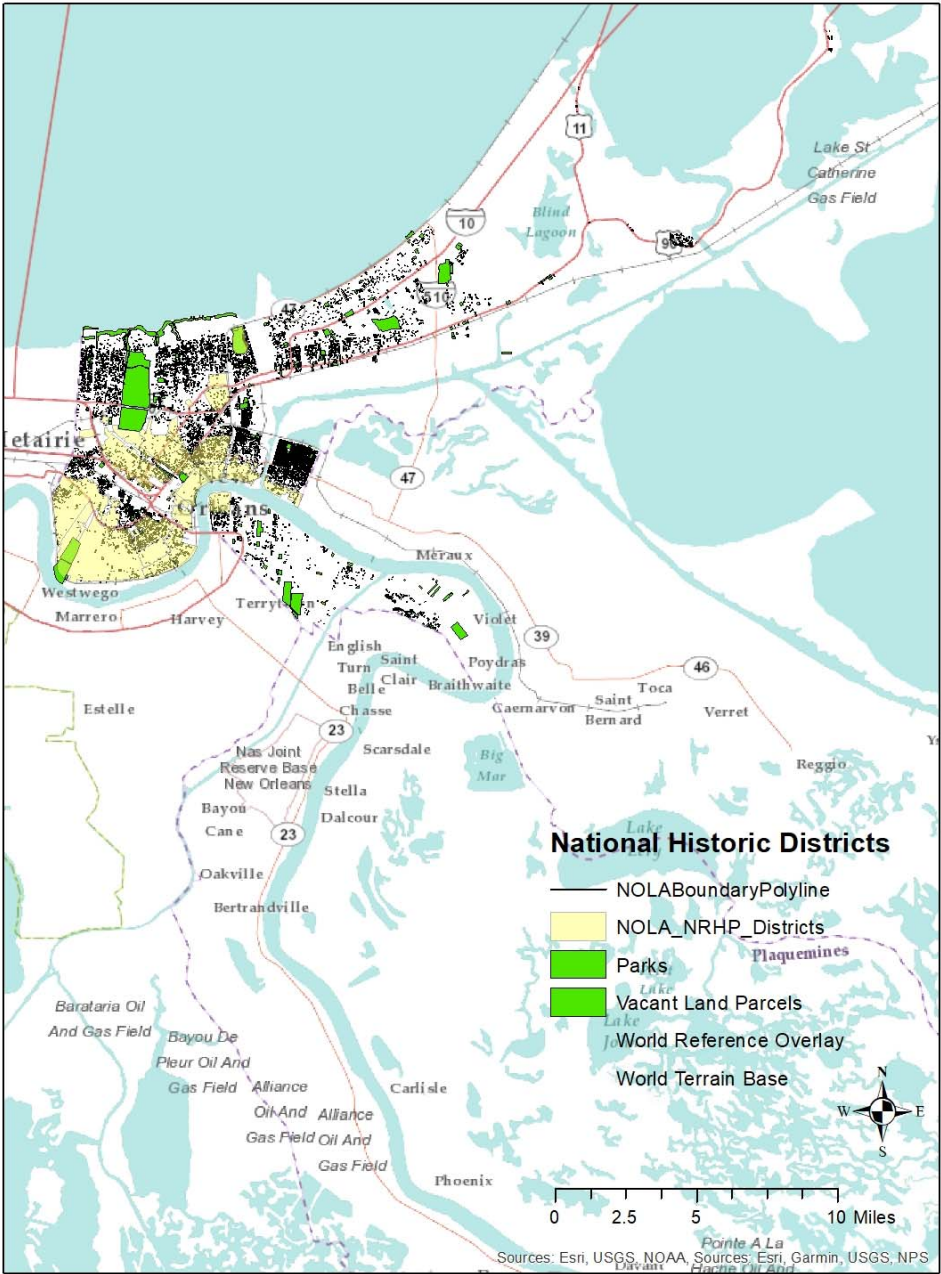


Figure 47: Publicly owned Vacant Land and National Register Historic Districts

#### **6.1.7 Technology Risk**

In addition to geophysical and social risks, technological risks, notably pollution was shown to impact habitat quality and vacancy. When all technological risks are averaged together, four percent of vacant land parcels were found in optimum habitat, twenty-eight percent in suboptimum habitat, and sixty-eight percent in marginal habitat. This finding supported the result of the analysis of opportunity and of geophysical and social risk. High quality habitat (optimum) supports occupancy and low quality habitat (marginal) vacancy.

##### **6.1.7.1 Proximity to Traffic and Vacancy**

Eighteen percent of vacant land parcels in New Orleans were found within census tracts with the least impact from traffic (optimum habitat). Twenty percent were found within the middle third of traffic impacts (suboptimum habitat) and forty-nine percent within census tracts with the worst traffic impacts (marginal habitat) (Figure 48).

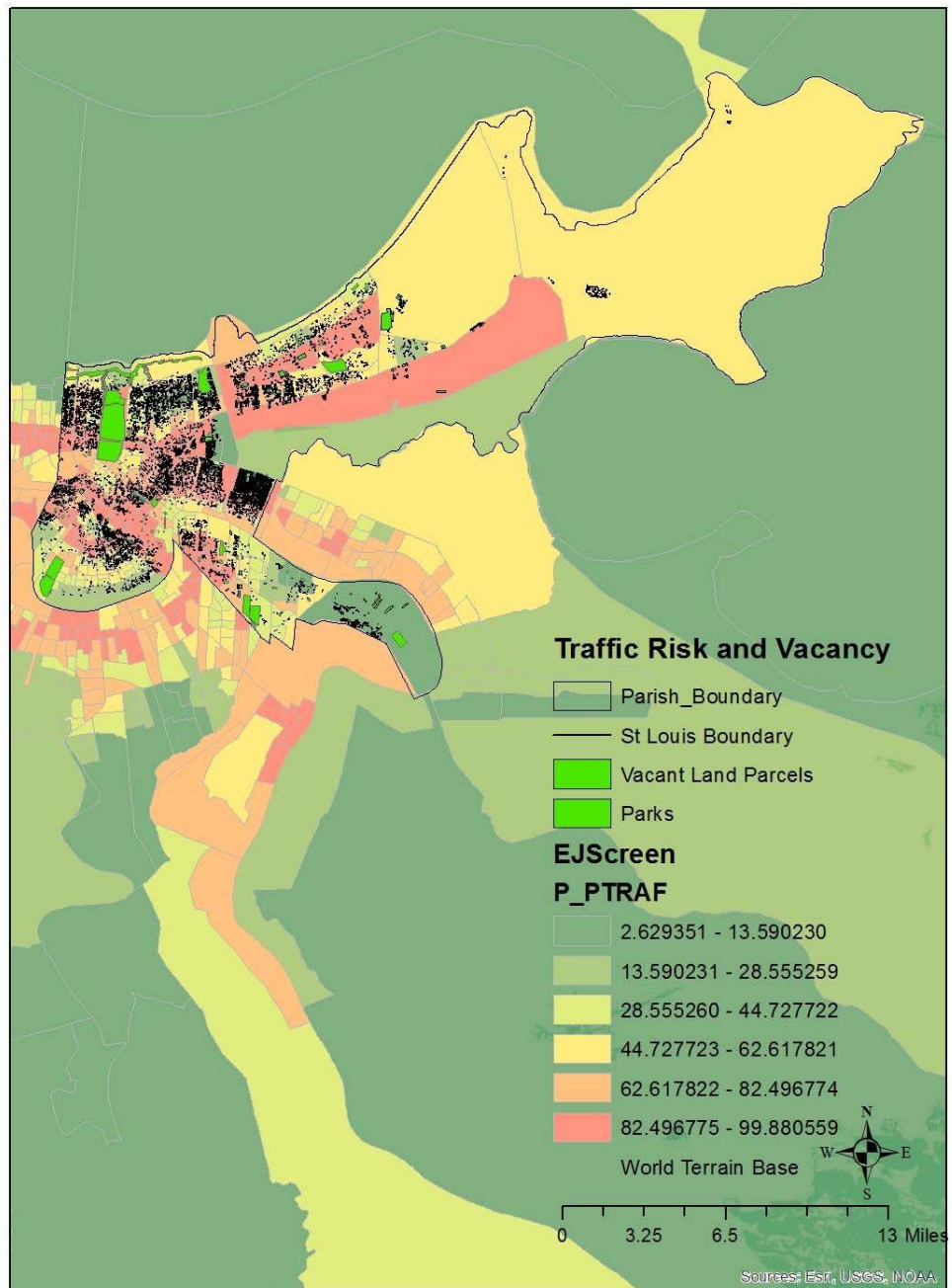


Figure 48: Traffic Risk and Vacancy

In addition to traffic impacts as measured by the Environmental Protection Agency EJ Screen, the Department of Transportation also measures noise levels from



roadways and airports. Seven percent of vacant land parcels are found in census tracts of 35-45 decibels (optimum habitat). Thirty-two percent are in census tracts with noise levels of forty-five to fifty-five decibels (suboptimum habitat) and sixty-one percent of vacant land parcels are in census tracts with noise level of fifty-five to sixty-five decibels (marginal habitat) (Figure 49).

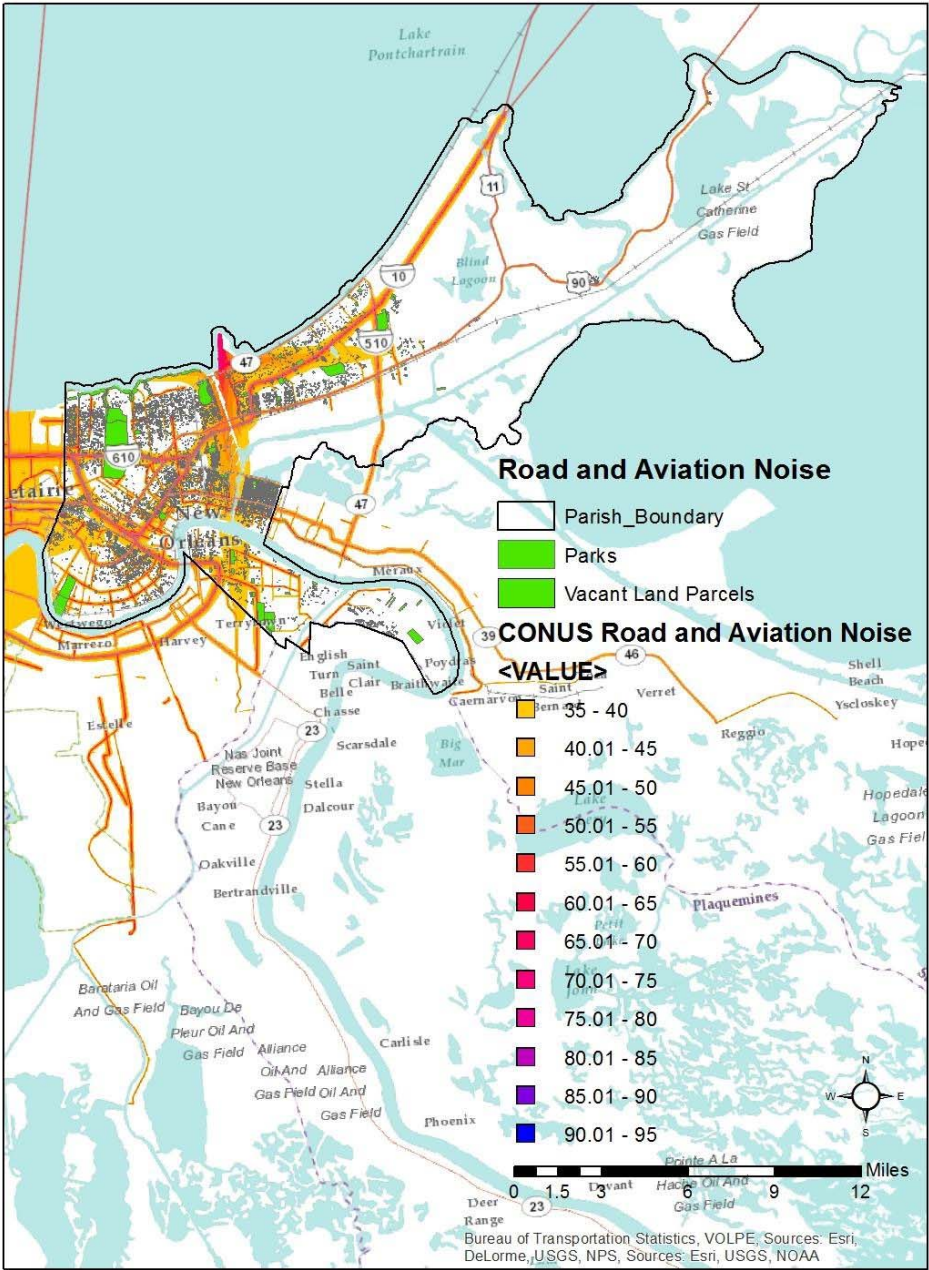


Figure 49: Noise and Vacancy



Figure 50: The Vieux Carré Expressway

The traffic impacts on the city could have been much worse had plans for the Vieux Carré Expressway been realized (Figure 50). The proposed Vieux Carré Expressway which would have separated the French Quarter from the Mississippi River is an example of a design proposal which would have created tremendous disturbance to this historic neighborhood. The highway proposal was abandoned because of tremendous public pressure in 1969 (Weingroff, 2016). In St. Louis, a similar proposal to construct I-755 through the heart of downtown to connect I-70 and I-64 was also defeated by public opposition. However, the design and construction of the Lafitte Greenway in New Orleans, which converted the former railyards within the city to public open space, can also be considered another form of disturbance yet this project has had positive impacts on adjacent neighborhoods (Culbertson, Martinich, 2013). Proposals to restore Claiborne Avenue in New Orleans seeks to reduce the impact of Interstate 10 on adjacent neighborhoods (*Smart Mobility*, Waggonner and Ball, 2010).

#### **6.1.7.2 Proximity to Cancer Risk**

A city heavily dependent upon the petrochemical industry for its economy, New Orleans has significant pollution. Cancer risk is a major consideration which impacts publicly owned land vacancy. Only two percent of publicly owned vacant land parcels are within optimum habitat, census tracts with a cancer risk equal to zero to fifty- four percent of the United States public (optimum habitat). Twenty-six percent of publicly owned vacant land parcels in New Orleans are within suboptimum habitat, census tracts with cancer risks less than or equal to fifty-four to eight percent of the United States population (suboptimum habitat). Seventy-two percent of publicly owned vacant land parcels are within marginal habitat, census tracts with cancer risk

less than or equal to eighty to one hundred percent of the United States population (marginalhabitat) (Figure 51).

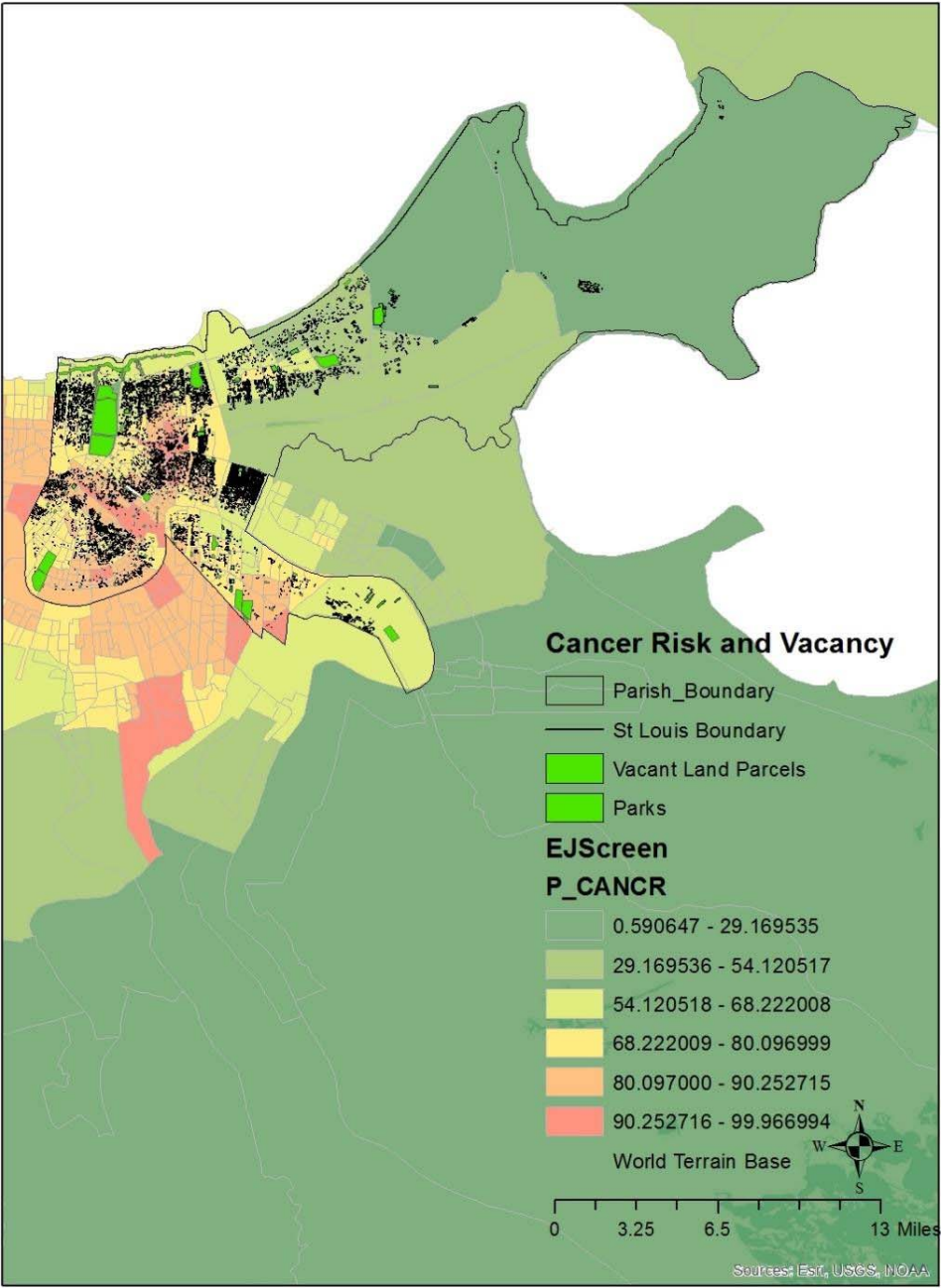


Figure 51: Cancer Risk and Vacancy



### 6.1.7.3 Proximity to Respiratory Risk

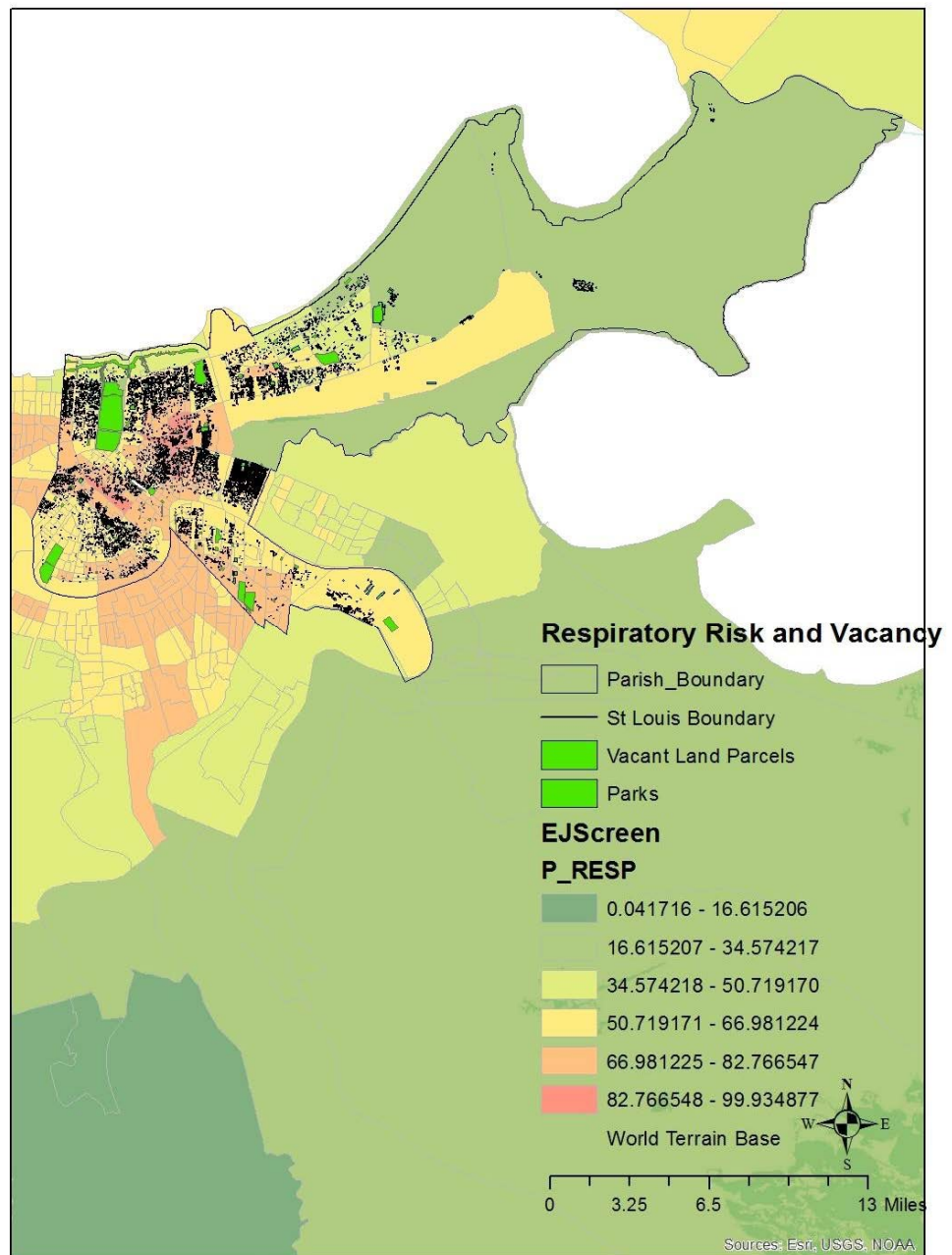


Figure 52: Respiratory Risk and Vacancy

One percent of publicly owned vacant land parcels in New Orleans were found in optimum habitat, census tracts with respiratory risk less than or equal to zero

to thirty-four percent of the United State population (Figure 52). Seventy-one percent of publicly owned vacant land parcels are in suboptimum habitat, census tracts with thirty-four to sixty-seven percent of the United States population and twenty-seven percent of publicly owned vacant land parcels are found in marginal habitat, census tracts with sixty-seven to one hundred percent of the United States population.

#### **6.1.7.4 Exposure to PM 2.5**

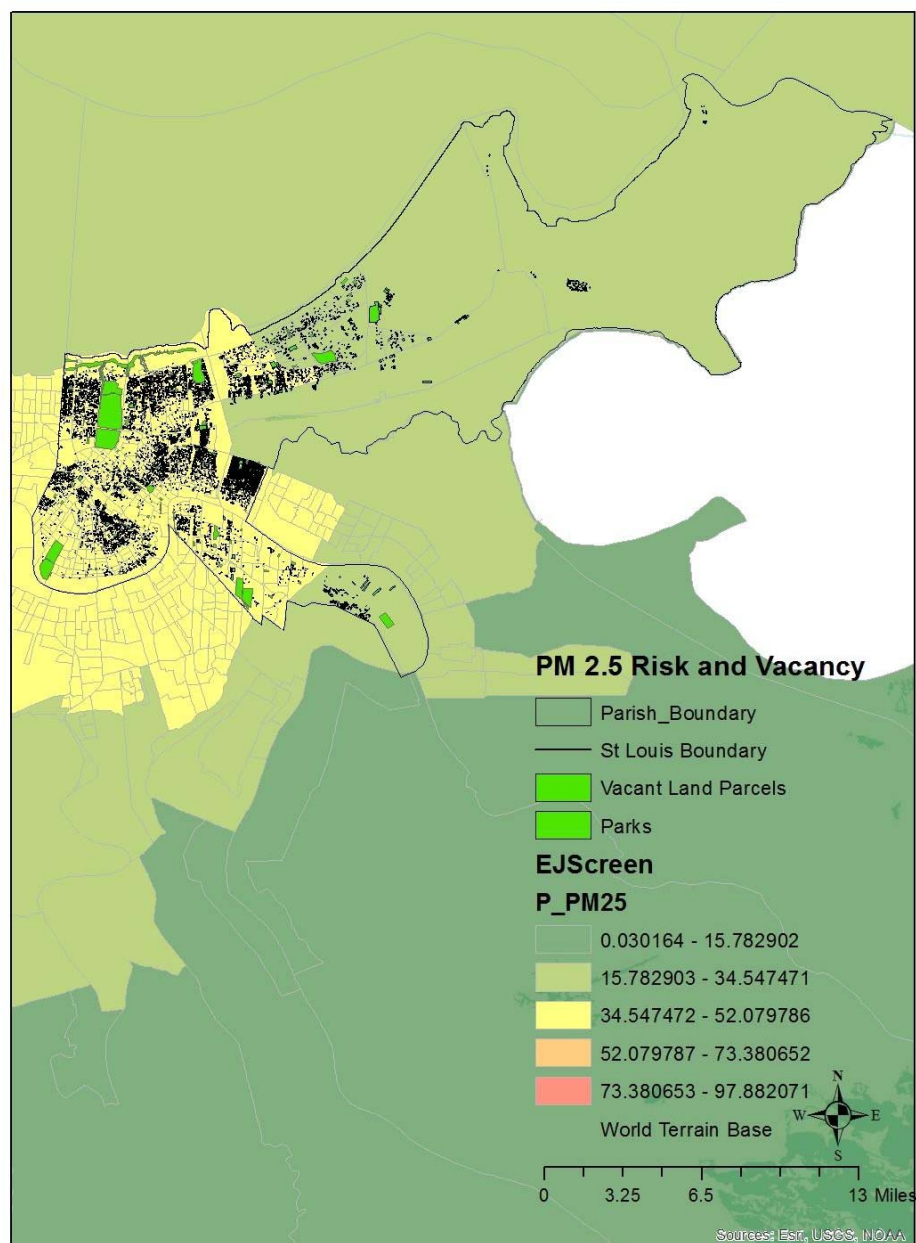


Figure 53: PM 2.5 and Vacancy

Though PM 2.5 pollution was more differentiated than the data on ozone pollution it was not detailed enough to differentiate habitat (Figure 53). Levels of this pollution were roughly equal across the city.

#### 6.1.7.5 Proximity to Diesel PM

The results for diesel pollution were similar to respiratory risk (Figure 54). One percent of publicly owned vacant land parcels were found in optimum habitat, six percent in suboptimum habitat, and ninety-three percent in marginal habitat.

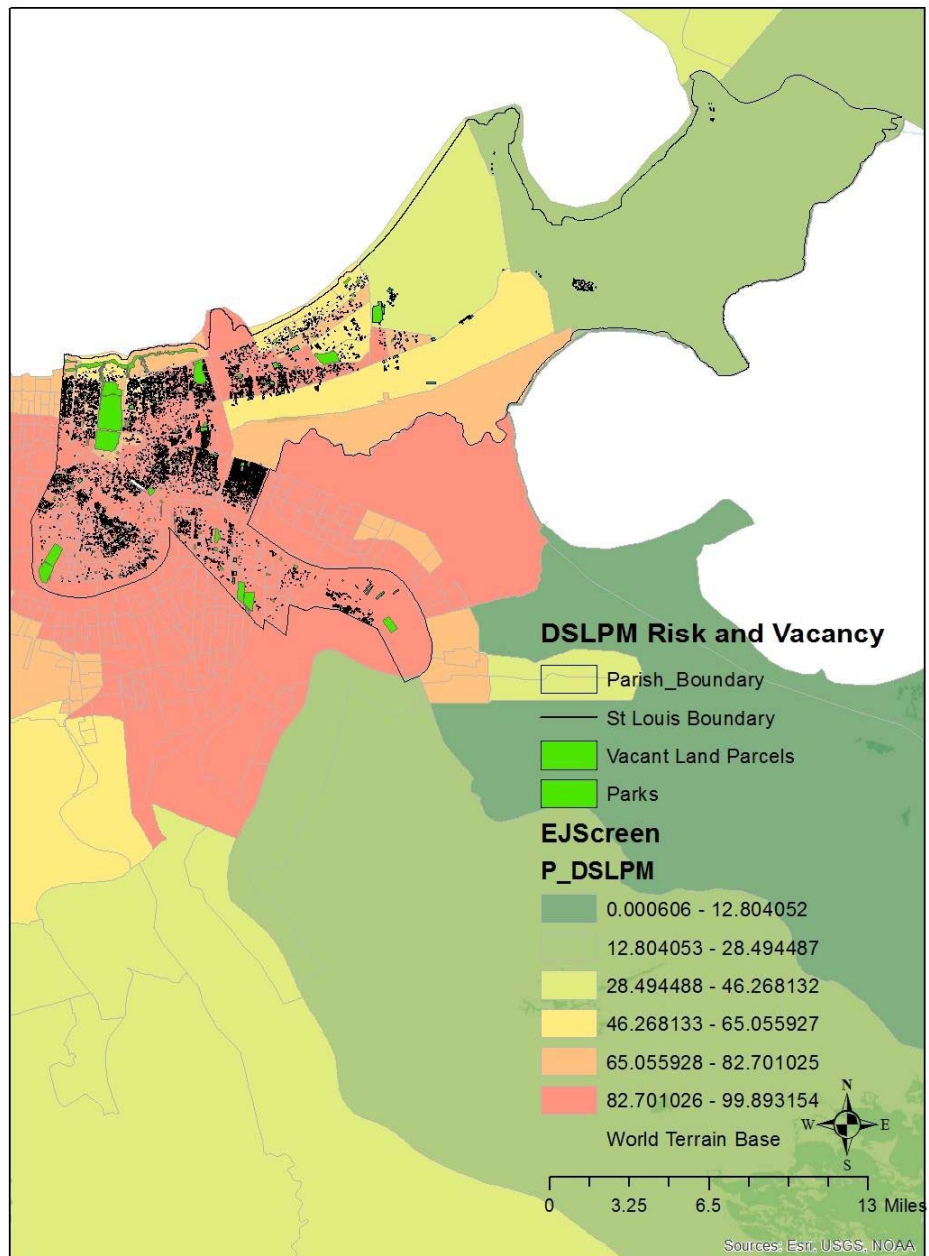


Figure 54: Diesel PM and Vacancy

### 6.1.7.6 Exposure to Ozone

Data on ozone pollution is not available at a census tract level and thus could not be utilized to differentiate habitat quality. As such it was not a useful indicator of habitat quality (Figure 55).

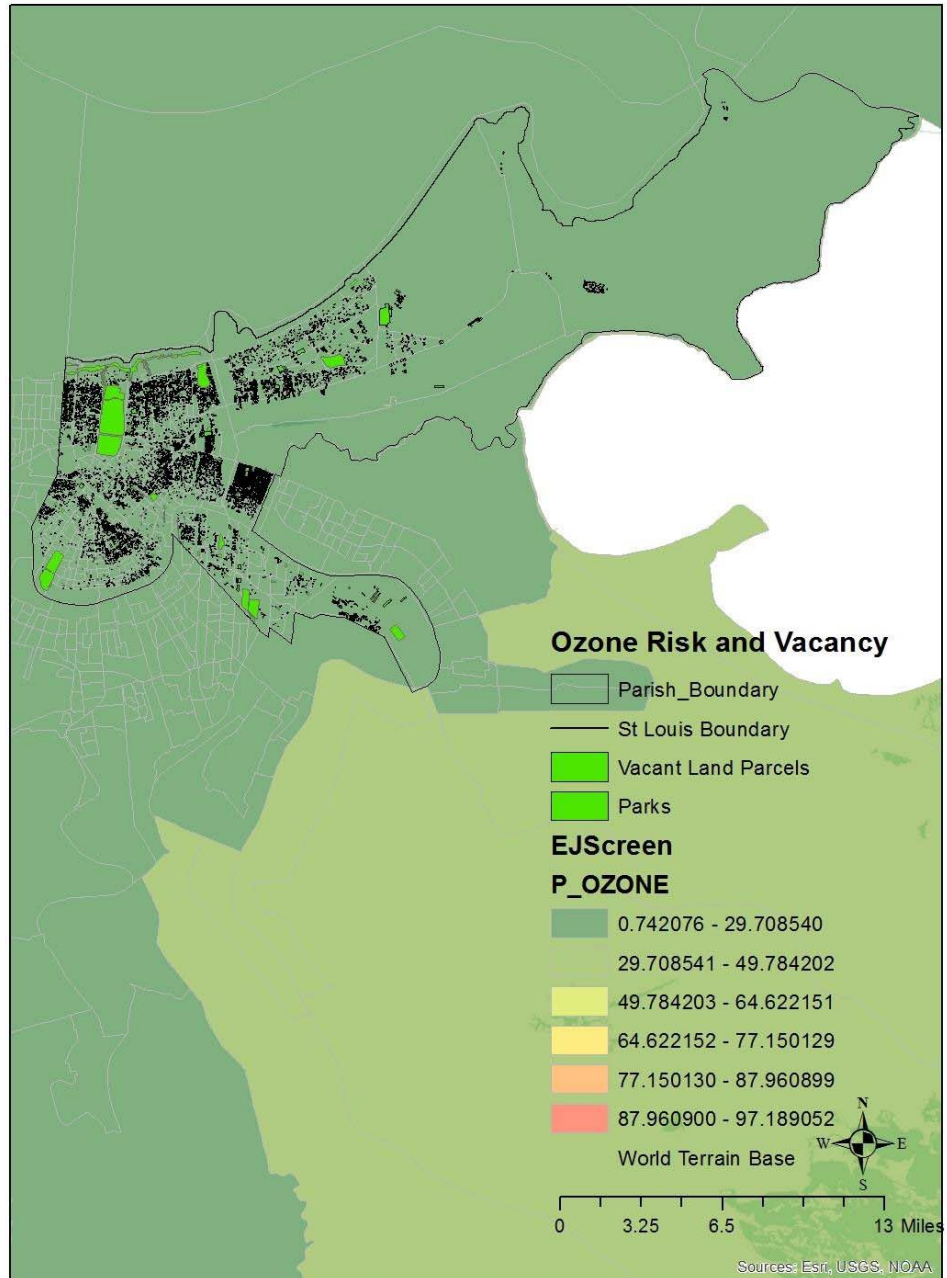


Figure 55: Ozone and Vacancy in New Orleans



#### 6.1.7.7 Proximity to EPA NPL (Superfund) Sites

No publicly owned vacant land parcels were found in optimum habitat based upon proximity to superfund sites, eight percent are found in suboptimum habitat, and ninety two percent in marginal habitat (Figure 56).

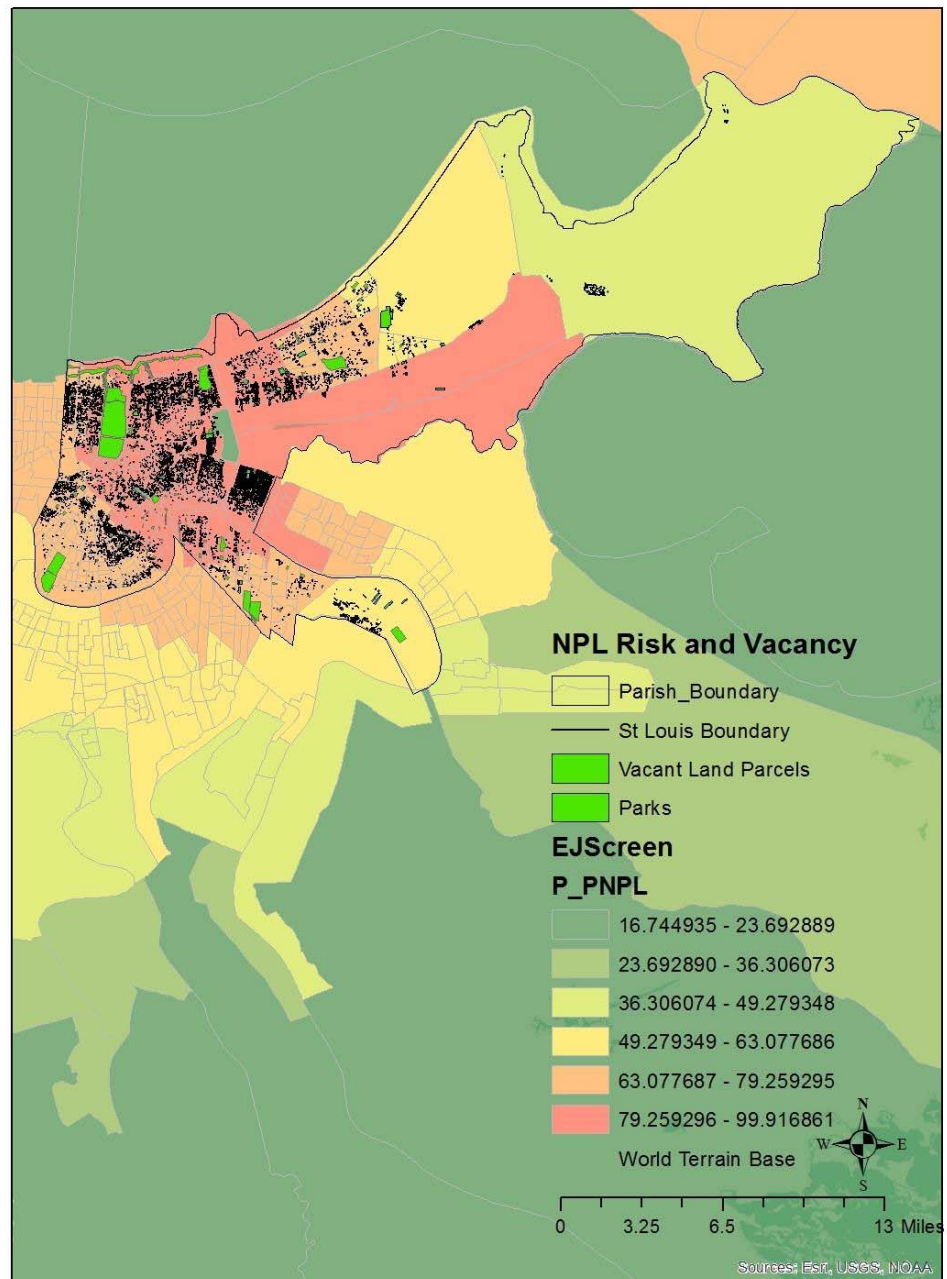


Figure 56: Vacancy and Proximity to NPL Superfund Sites

#### 6.1.7.8 Proximity to EPA RMP Sites

RMP sites which present the potential for chemical accidents are another major pollution concern in the city (Figure 57). Based upon this factor, one percent of publicly owned vacant land parcels in New Orleans were in optimum habitat, eighteen percent in suboptimum habitat, and eighty-one percent in marginal habitat.

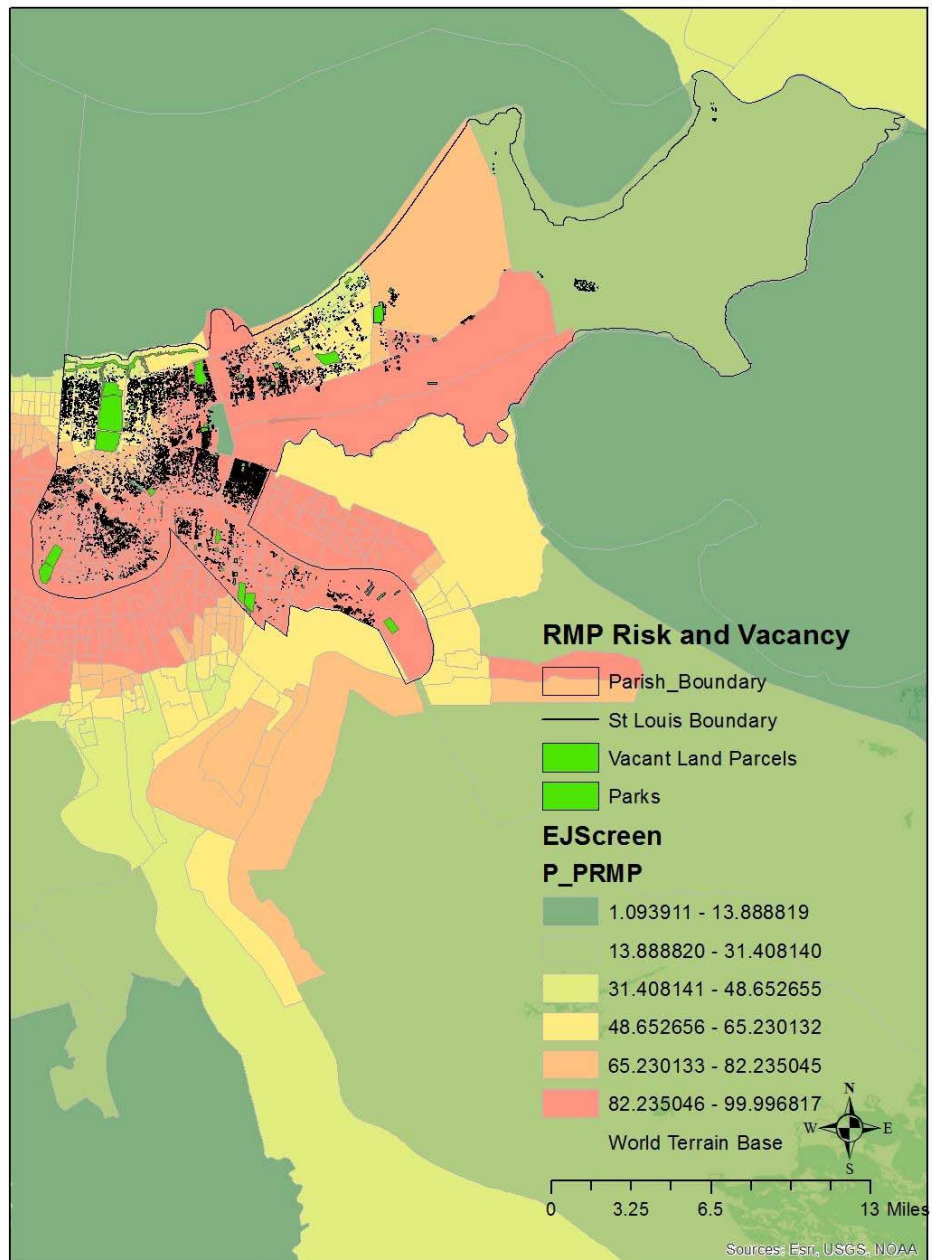


Figure 57: Vacancy and Proximity to RMP Sites

#### 6.1.7.9 Proximity to Treatment and Storage Disposal Facilities

Treatment and storage disposal facilities include proximity to such facilities as landfills and waste incinerators. Less than one percent of publicly owned vacant land

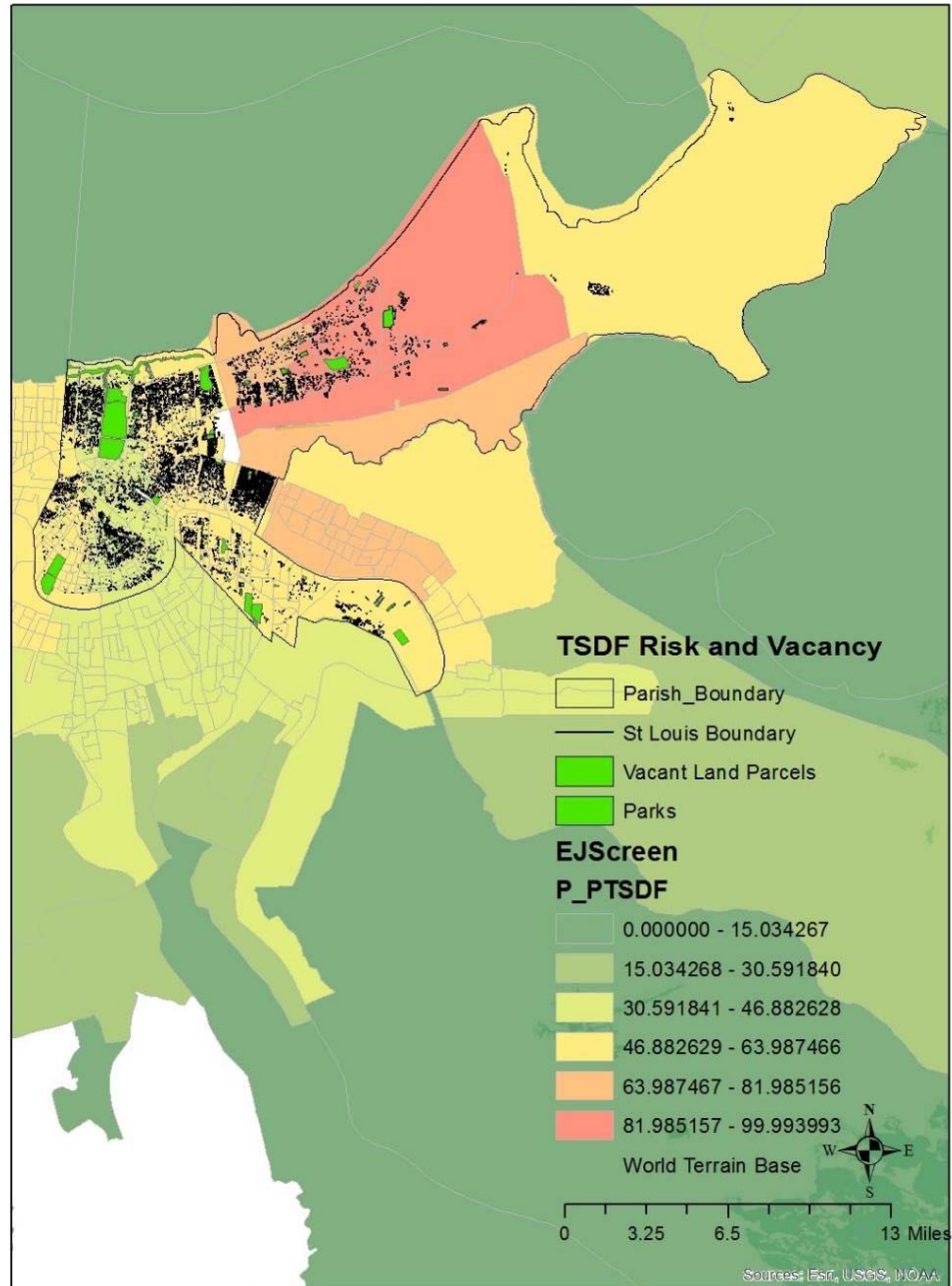


Figure 58: TSD Risk and Vacancy



parcels in New Orleans are distant from these facilities. Sixty-two percent are found in what would be considered suboptimum habitat and thirty-eight percent in marginal habitat (Figure 58).

#### **6.1.7.10 Proximity to Lead**

Lead is found in the environment of New Orleans in two forms (Figure 59). One is in the paint of older homes which have not been remediated or remodeled since lead paint was outlawed in 1978. Census tracts with the highest levels of lead paint contamination (marginal habitat) contain seventy-two percent of all publicly owned vacant land parcels in New Orleans. Those in the middle third of contamination (less than or equal exposure to forty to seventy percent of the United States public) contain eighteen percent of all lead paint contamination. Those census tracts which contain the least lead paint exposure contain ten percent of all vacant land parcels.

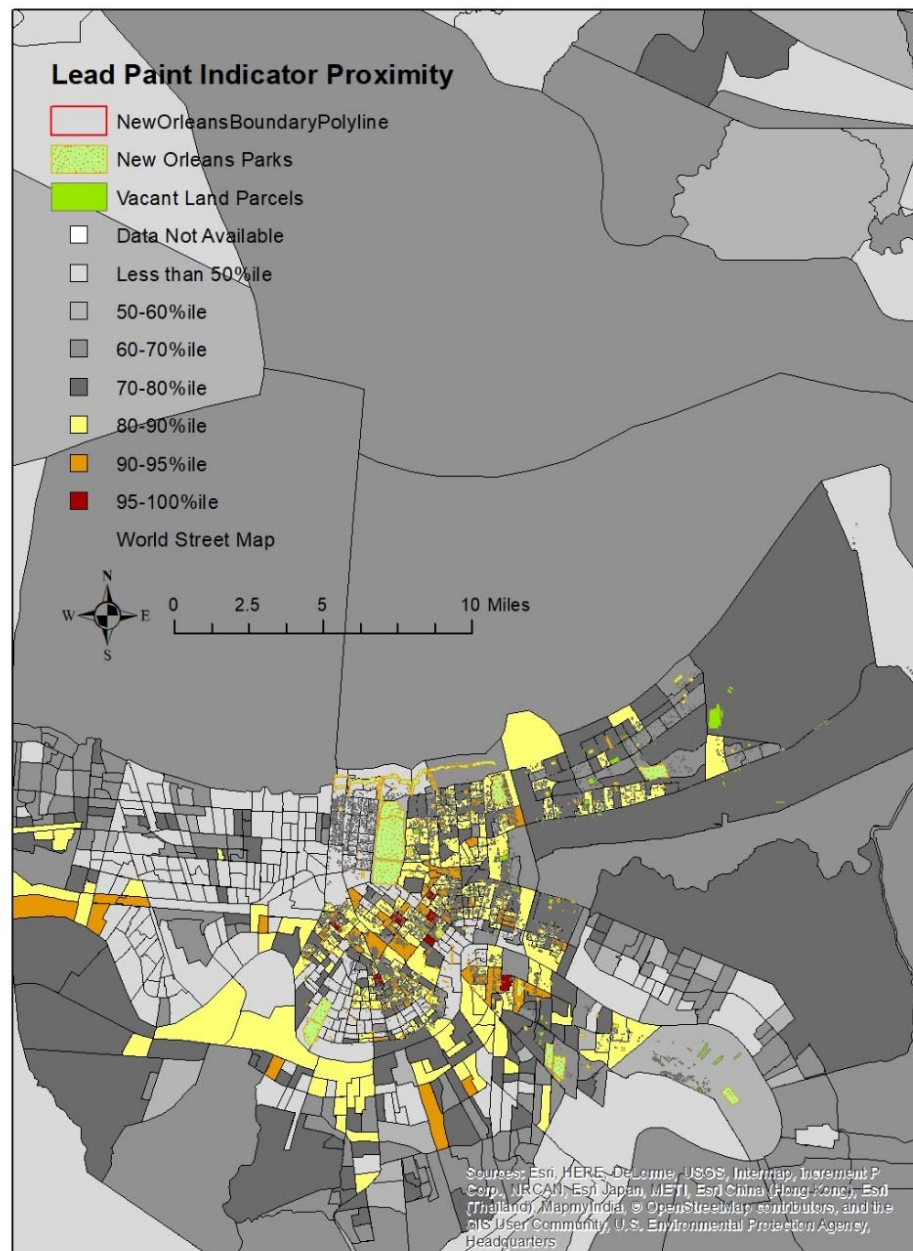


Figure 59: Lead Paint and Vacancy in New Orleans

Lead in New Orleans is also prevalent in the soil of the city because of the use of lead as an additive to gasoline and because of the city's industrial heritage. While this data was not available in digital form only a visual comparison of soil lead levels

and vacancy is possible (Figure 55).

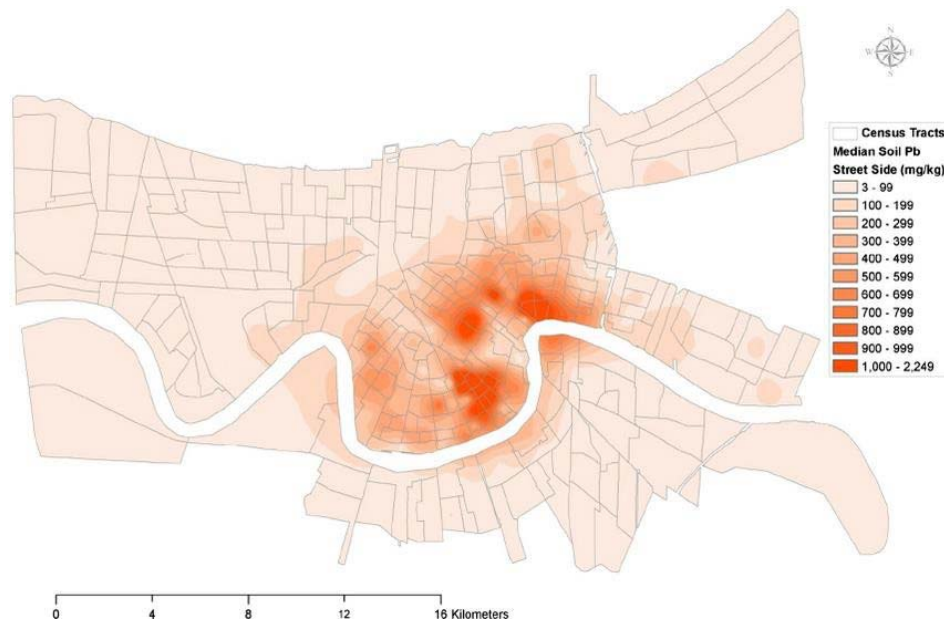


Figure 60: Soil Lead Map of New Orleans

#### 6.1.7 Natech Risk

Through history natech risk in New Orleans included flooding and wind related damage to the city's industrial districts. These geophysical conditions exacerbated pollution levels through dispersion. This is particularly true of the areas of the city bordering the Industrial Canal. These areas contain some of the highest concentrations of publicly owned land vacancy in the city.

#### 6.1.8 Real Estate Values and Land Vacancy

The summary of all risks including geophysical, social, and technological risks found that found that seventeen percent of all vacant land parcels were in optimum habitat, thirty percent in suboptimum habitat, and fifty-three percent in marginal habitat.

Real estate values were found to generally mirror this pattern with only

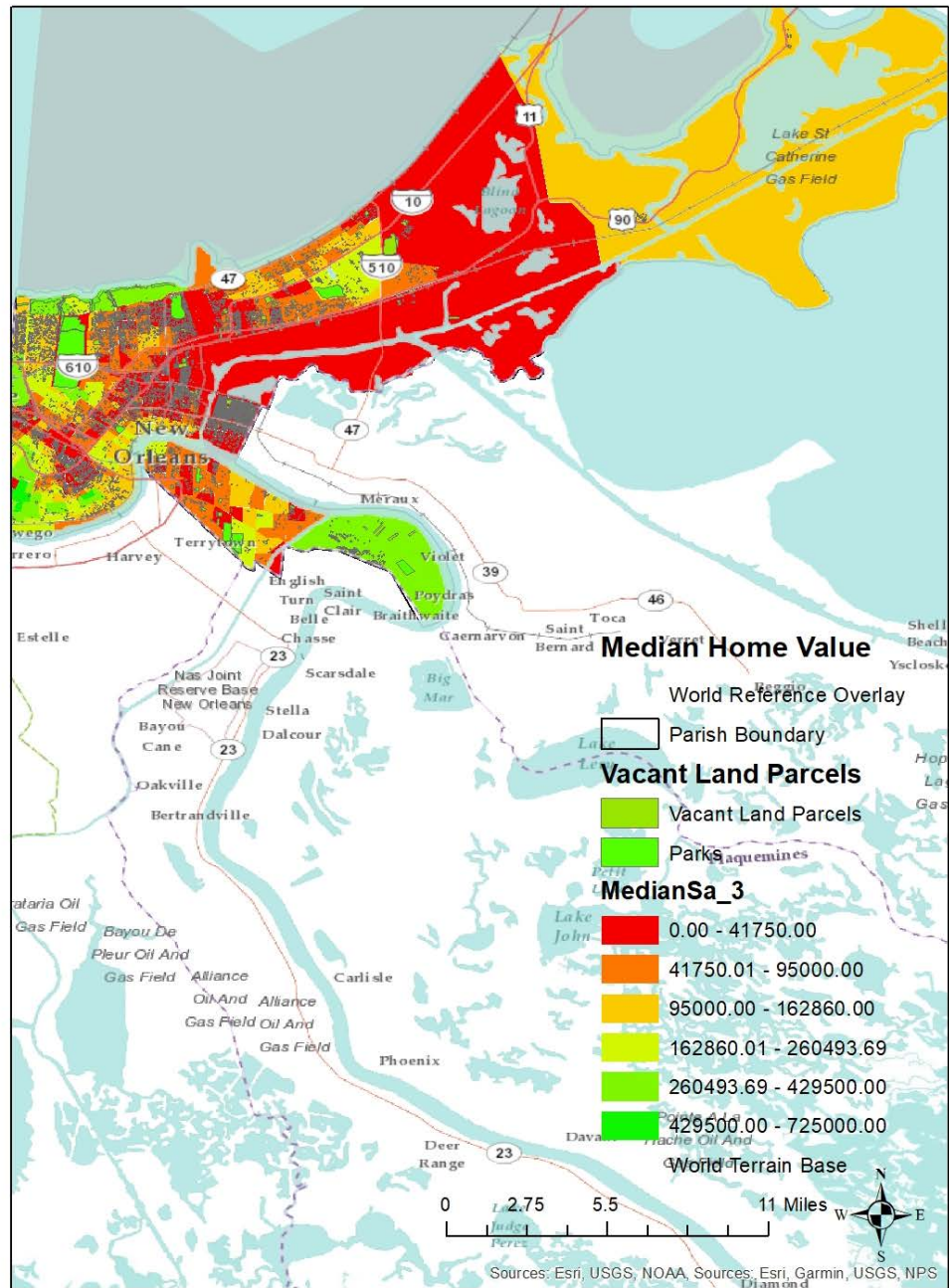


Figure 61: Median Home Values and Vacancy in New Orleans

two percent of publicly owned vacant land parcels in New Orleans in optimum habitat, twenty-five percent in suboptimum habitat, and seventy-three percent

in marginal habitat. Although the percentages are not precisely parallel, this finding demonstrates that real estate values were an indicator of habitat quality (Figure 61).

## **6.2 COMMON FIELDS: LESSONS FROM ST. LOUIS**

### **6.2.1 Historical Ecology of St. Louis**

As outlined in the methodology, historical maps were georeferenced and digitized to create a map which depicts the Historical Ecology of St. Louis Prior to European Settlement. Land vacancy was then compared to the habitat Quality Model: Prior to European Settlement to understand the relationships between historical ecology and publicly owned vacant land.



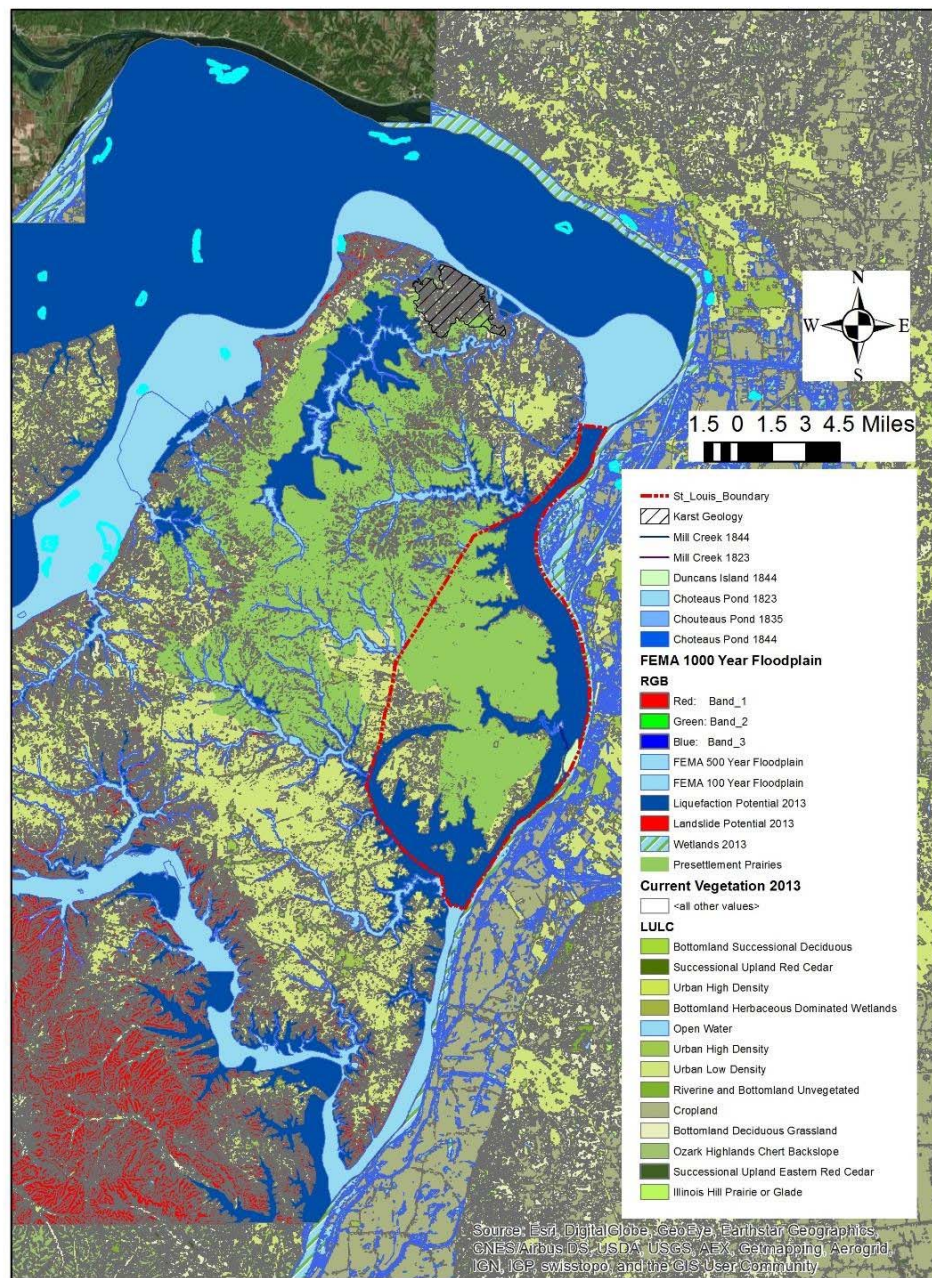


Figure 62: Historical Ecology of St. Louis

From the Map of Historical Ecology of St. Louis (Figure 62), a ternary Habitat Quality Model was developed. The high ground which contained pre-settlement prairies was classified as optimum habitat because it was the portion of



the site of the city that was least prone to periodic flooding and water borne illness. The stream corridors and the 500-year floodplain of the Mississippi River were classified as suboptimum habitat. Areas subject to liquefaction and the 100-year floodplain of the Mississippi River were classified as marginal habitat because of the potential for severe flooding. Publicly owned vacant

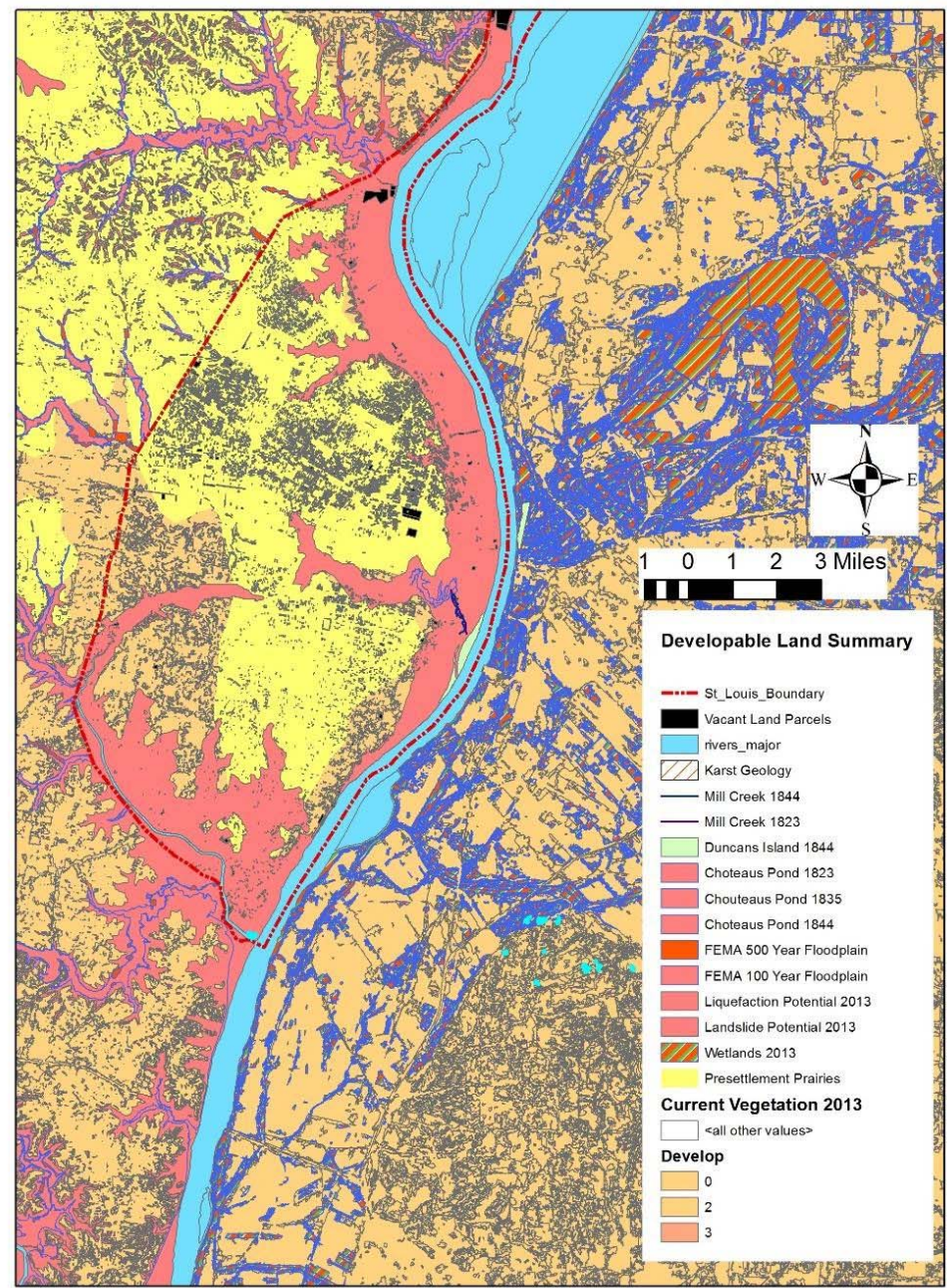


Figure 63: Developable Land Summary of St. Louis

land parcels were then overlaid over the Habitat Quality Map of conditions prior to European settlement conditions and examined. The contrast from New Orleans was remarkable. Where eighty percent of publicly owned vacant land parcels in New Orleans are on land considered suboptimum or marginal based upon the historic ecological condition, ninety-seven percent of publicly owned vacant land parcels in St. Louis are on land rated optimum based upon the geophysical condition. Only three percent of publicly owned vacant land parcels in St. Louis are located in marginal habitat. This demonstrated the site of St. Louis to be an exceptional site for habitation by *Homo sapiens* (Figure 63).

### **6.2.2 Habitat Quality Model of St. Louis – Present**

As with the New Orleans analysis, a map layer of publicly owned vacant land parcels was laid over map layers of each the individual opportunities and risks to understand those relationships. The percentage of the total publicly owned vacant land parcels with optimum, suboptimum, and marginal habitat was then calculated. Some factors were, however, eliminated from the model because data was not available at a census tract level and provided no differentiation of habitat quality. This included access to energy resources and exposure to ozone and pm 2.5 pollution. Information on proximity to quality education and unemployment was also not available on a census tract basis and thus the influence of these factors could not be considered independently. These factors were contained within the Kirwan Institute opportunity maps and were evaluated utilizing this information. In addition, information technology was physically available to all residents though internet service is perhaps not accessible to all residents based upon affordability but was not considered a differentiation of habitat quality. Tax policy was uniform across the city and thus also offered no differentiation of habitat quality. Because of the lack of data for classification, no effort was made to categorize habitat based upon proximity to cultural resources or the quality of urban design.

### **6.2.3 Proximity to Opportunities and Land Vacancy**



Based upon the opportunity map for overall opportunity prepared by the Kirwan Institute, three percent of publicly owned vacant land parcels in St. Louis are found within optimum habitat, four percent within suboptimum habitat, and ninety-three percent within marginal habitat. The Kirwan Institute map for educational opportunity demonstrated that three percent of all publicly owned vacant land parcels lay within areas considered optimum habitat, five percent within suboptimum habitat, and ninety-two percent marginal habitat. Social and economic opportunity as illustrated by the Kirwan Institute map, demonstrated nine percent of publicly owned vacant lands lie within optimum habitat, nine percent of publicly owned vacant land parcels lie within suboptimum habitat, and eighty-two percent within marginal habitat. The Kirwan Institute map for health and environmental opportunity demonstrated that eight percent of publicly owned vacant land parcels lie within optimum habitat, two percent within suboptimum habitat, and ninety percent within marginal habitat. As in New Orleans comparison of the Kirwan opportunity maps and the location of publicly owned vacant land parcels suggests an extremely strong relationship between proximity to opportunity and occupancy and between the absence of opportunity and vacancy. The lack of opportunity in St. Louis appeared to be more severe than in New Orleans, counteracting the benefits of the exceptional geophysical conditions of the city.

#### **6.2.4 Proximity to Opportunity and Land Vacancy**

The opportunity maps of the Kirwan Institute are based upon locally derived factors and are specific to each city. The same pattern observed in New Orleans is found in St. Louis. Based upon the Kirwan Institute's mapping of overall opportunity in St. Louis, only three percent of publicly owned vacant land parcels are found in the census tracts with the greatest opportunity (optimum habitat), four percent in the middle third of opportunity (suboptimum habitat), and ninety-three percent in census

tracts with the lowest opportunity (Figure 64).

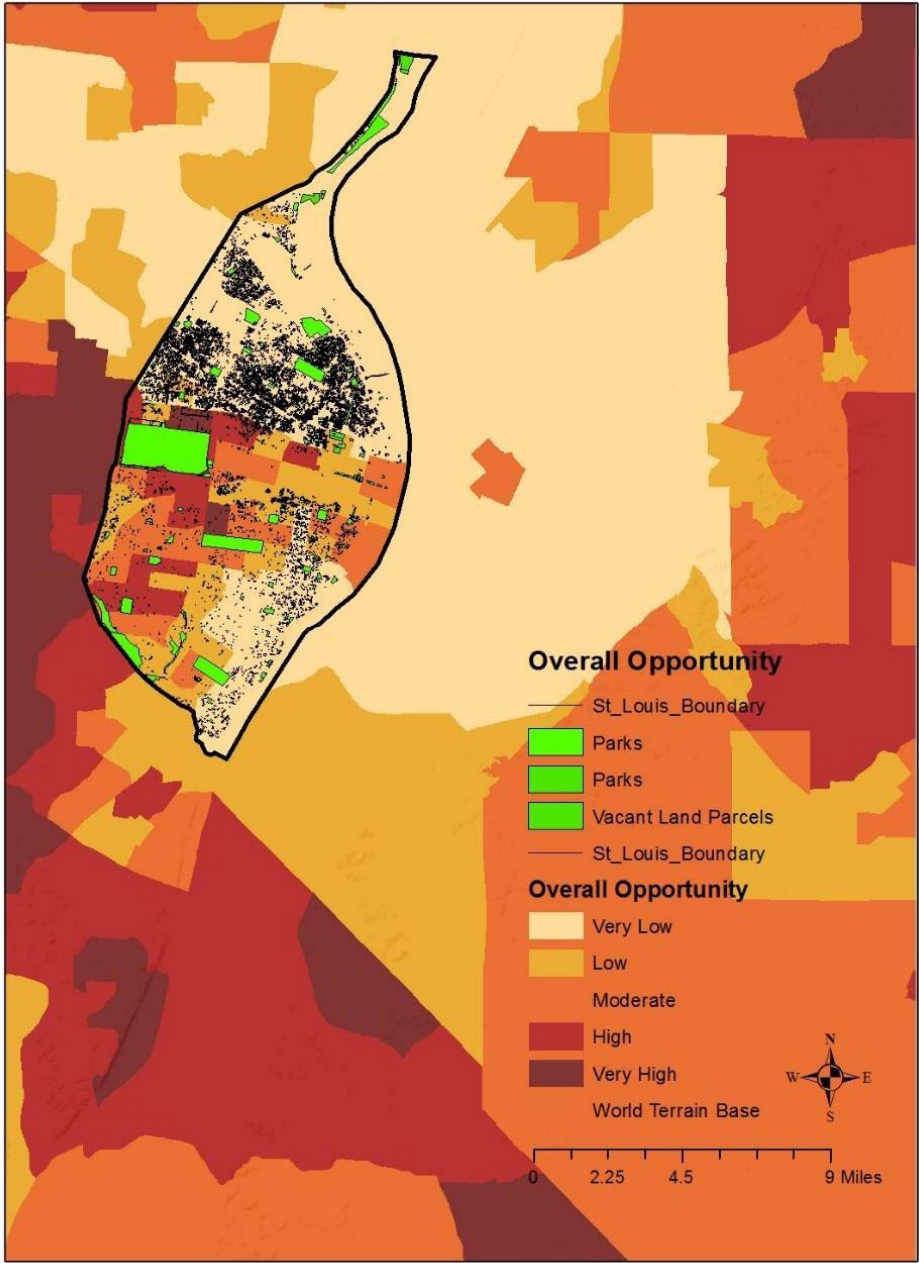


Figure 64: Overall Opportunity and Vacancy in St. Louis

An almost identical pattern was found when considering educational opportunity. Three percent of publicly owned vacant land parcels in St. Louis are found in the census tracts with the greatest opportunity (optimum habitat) , five percent

in the middle third (suboptimum habitat), and ninety-two percent in the census tracts with the least opportunity (marginal habitat) (Figure 65). Dramatic improvements in educational opportunity can be observed as one crosses the city limit line into St. Louis county.

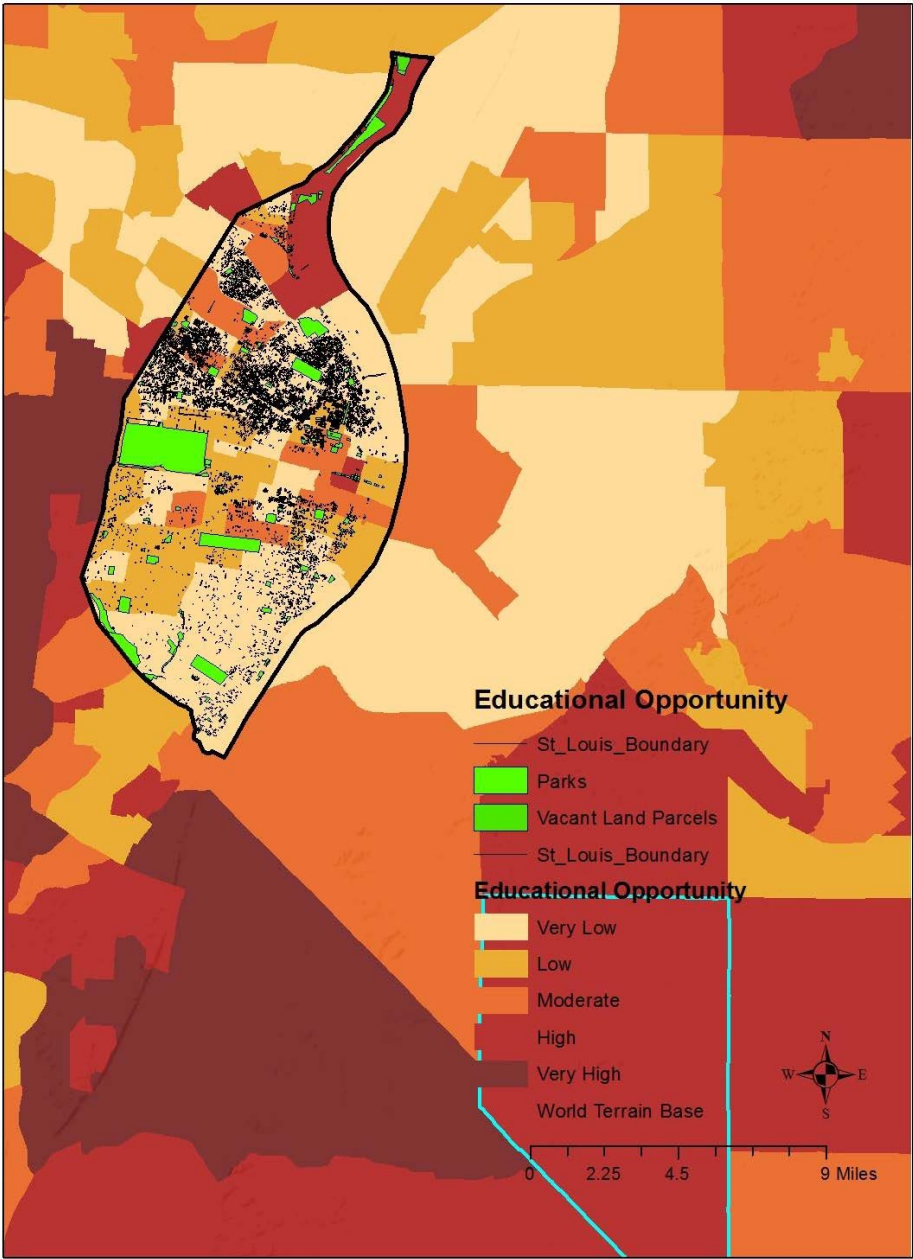


Figure 65: Education Opportunity in St. Louis

A somewhat better condition exists when considering social and economic opportunity (Figure 66). Nine percent of publicly owned vacant land parcels in St. Louis are found within the census tracts with the best opportunity by this measure (optimum habitat), ten percent in the middle third of census tracts (suboptimum habitat), and eighty-two percent in the census tracts with the least social and economic opportunity (marginal habitat). It is hypothesized that conditions are somewhat improved by this measure because of the proximity of jobs in the city's

major industrial districts to these census tracts (Figure 66).

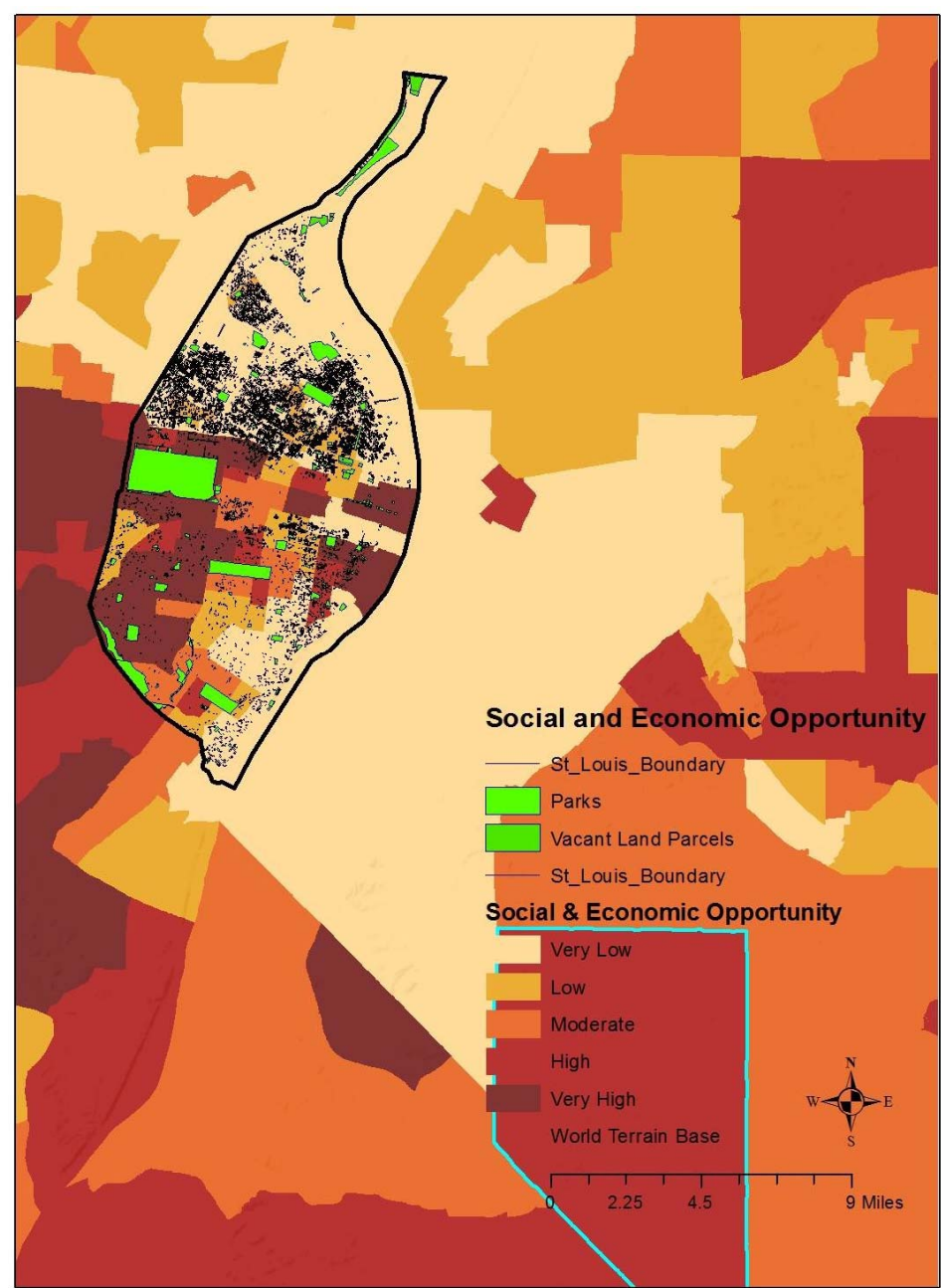


Figure 66: Social and Economic Opportunity and Vacancy in St. Louis

The pattern continues when considering health and environmental opportunity.

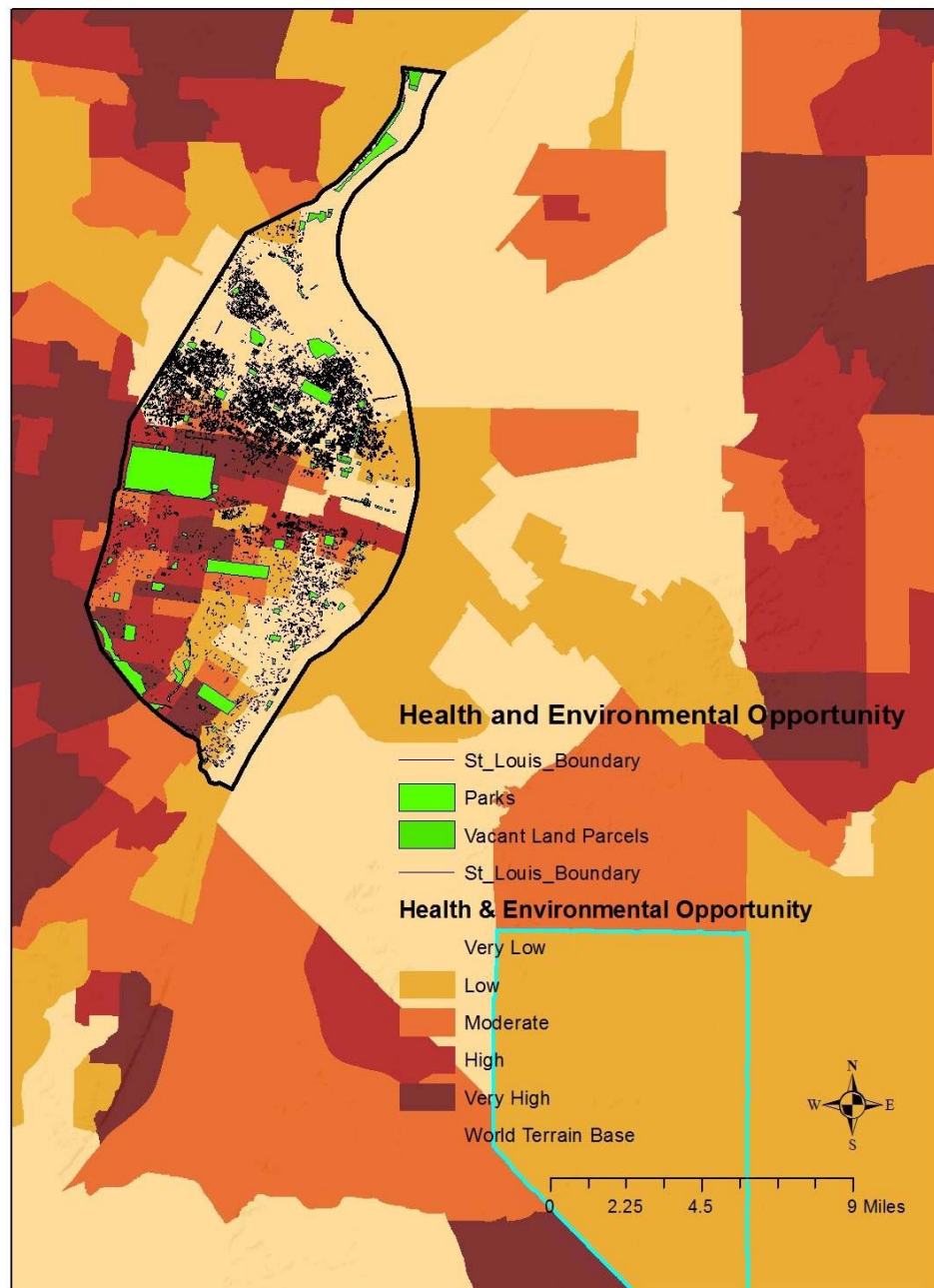


Figure 67: Health and Environmental Opportunity and Vacancy in St. Louis

By average the distribution of vacant land parcels across all opportunity factors, it was found that nine percent of publicly owned vacant land parcels in St. Louis lie within optimum habitat, seven percent within suboptimum habitat, and



eighty-four percent within marginal habitat (Figure 67). An examination of the data for St. Louis clearly demonstrated a very strong relationship between the absence of opportunity and land vacancy.

6.2.4.1 Proximity to Employment

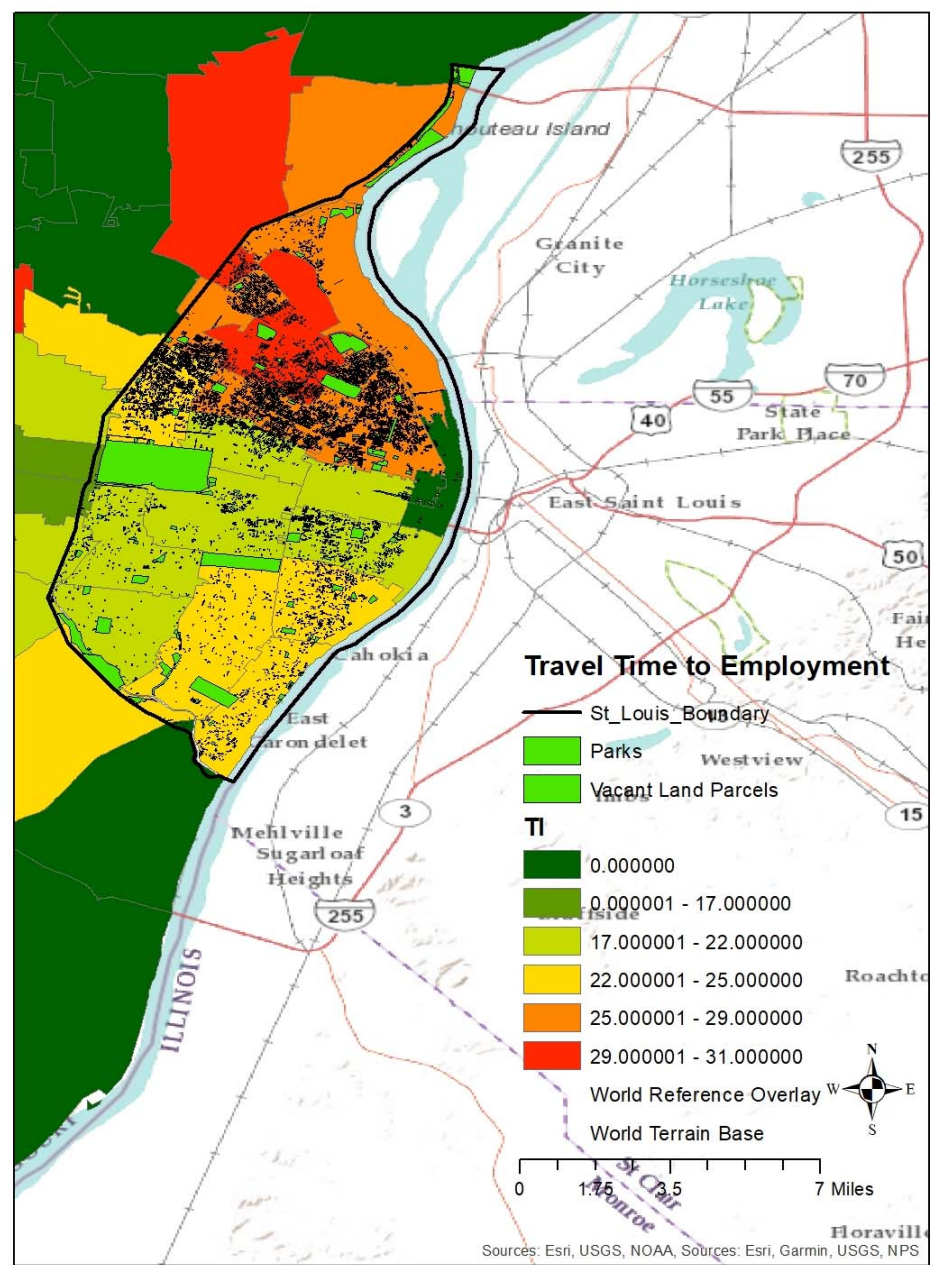


Figure 68: Travel Time to Employment

The census tracts with the longest commute times in St. Louis at 23-31 minutes (marginal habitat) contain sixty-five percent of the publicly owned vacant land parcels in the city. Census tracts with commute times of 20-23 minutes (suboptimum habitat) contained twenty-two percent of vacant land parcels. And census tracts with the shortest commute times (0-20 minutes) contained thirteen percent of vacant land parcels (Figure 68).

#### **6.2.4.2 Proximity to Transportation**

It was anticipated that proximity to transportation, including rail or streetcar transit, automobile access, and air access influence habitat quality. Commute time to employment and the negative impact of pollution were considered as part of the mapping of factors available from the EPA EJScreen. Further examination of the benefits and impact of transportation, particularly light rail and streetcar on habitat quality was warranted but beyond the scope of this study.

#### **6.2.4.3 Proximity to Education**

Information on the location of schools in St. Louis is available as a GIS shapefile. However, information on the relative quality of schools in St. Louis is not available, so assessing the relative proximity to quality education was not possible with available data. The Kirwan Institute opportunity mapping did factor in educational quality and this information was utilized as a measure of educational quality.

#### **6.2.4.4 Proximity to Information Technology**

Data available from PolicyMap suggests that internet access in St. Louis is ubiquitous. It is likely that cable or fiber exists to every home within the city. However, market penetration of these services likely vary according to one's ability to pay. Spatial data illustrating the market penetration of internet service was unavailable.

#### **6.2.4.5 Proximity to Energy**



Modeling energy input in St. Louis was beyond the scope of this research. Energy flows were examined spatially by considering the location of powerlines and gas transmission pipelines. A review of national GIS mapping data available from ESRI indicates that there are no major powerlines or pipelines within St. Louis or that available data is not at sufficient scale to indicate the location of such lines. Electrical service is believed to be ubiquitous and available to all residents, though access may vary according to one's ability to pay.

#### **6.2.4.6 Proximity to Food Supplies**

As in New Orleans, access to quality food supplies as mapped by the United States Department of Agriculture data demonstrated a strong relationship with vacancy. Sixteen percent of the publicly owned vacant land parcels in St. Louis were found within optimum habitat based upon this measure. None of the vacant land parcels in St. Louis were in areas of suboptimum habitat, and eighty-four percent within marginal habitat (Figure 69). These areas are considered food deserts by the United States Department of Agriculture. The influence of food deserts in St. Louis was shown to be greater than in New Orleans.

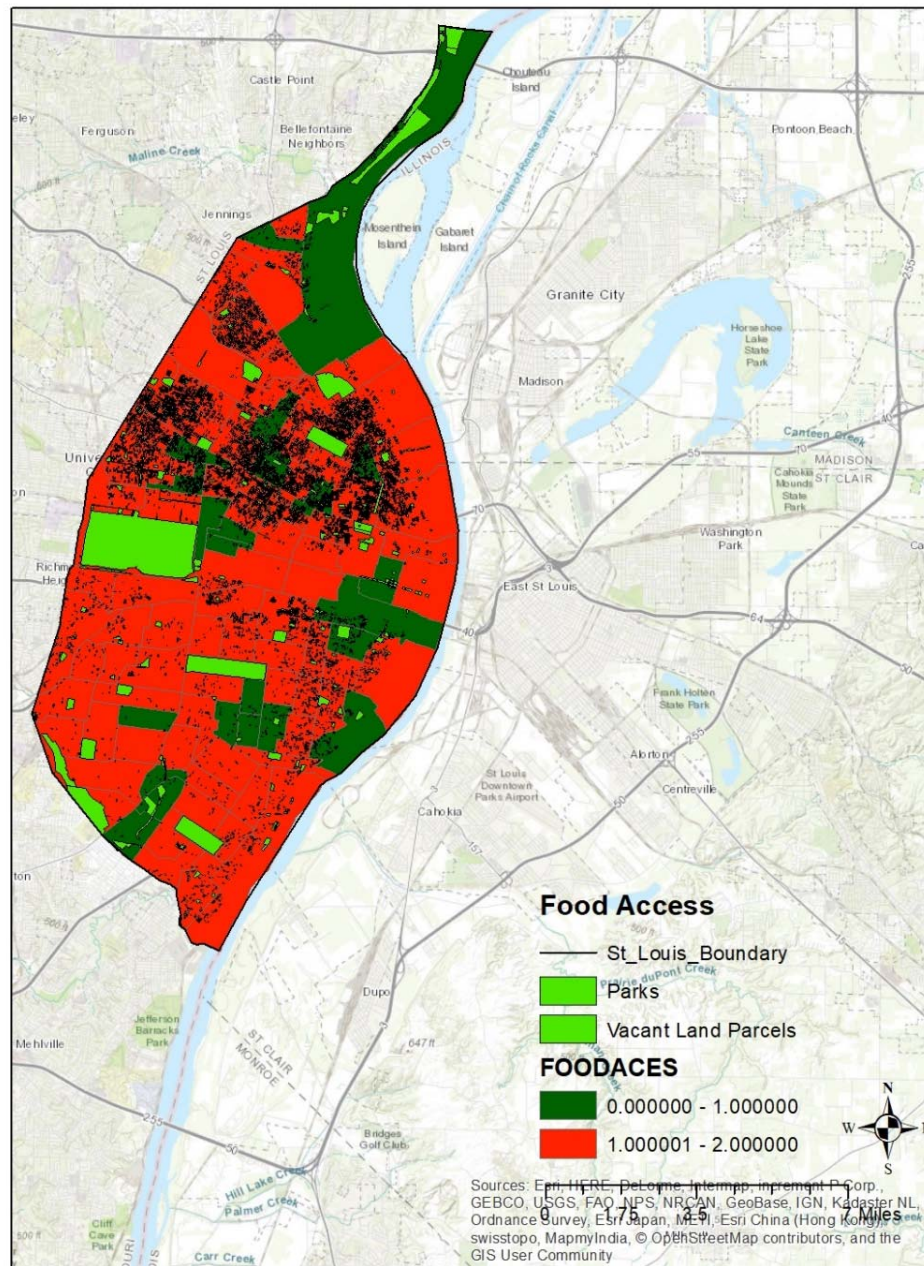


Figure 69: Food Access and Vacancy in St. Louis

#### 6.2.4.7 Proximity to Goods and Services

Although not mapped as part of this research, it was recognized that accessed to locally serving retail and the ability to obtain goods and services. Typically,

grocery stores serve as an anchor tenant in shopping centers so that areas that are underserved by food supplies are also underserved by other forms of retail. Habitat quality mapping based upon proximity to food supply may, therefore, also indicate areas lacking in proximity to other goods and services.

#### **6.2.4.8 Proximity to Cultural Resources and Places of Worship**

Proximity to entertainment and other cultural resources such as museums, art galleries, and sports venues can also impact habitat quality. Places of worship can also impact habitat quality. The identification of the myriad cultural resources that influence habitat quality was beyond the scope of this study and not included in the habitat quality model.

#### 6.2.4.9 Proximity to Parks and Open Space

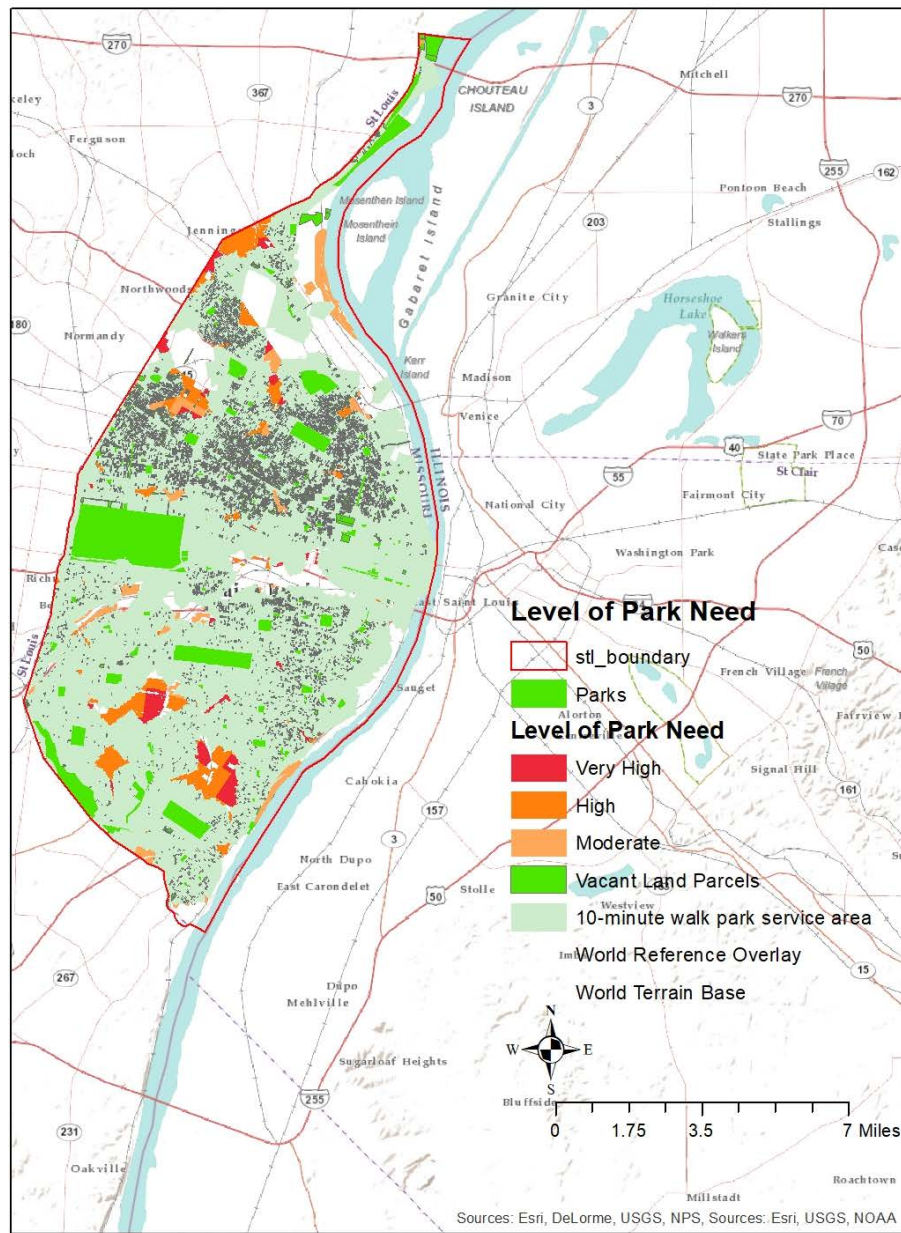


Figure 70: Park Need and Vacancy in St. Louis

The ParkScore system of the Trust for Public Land, which classifies areas of a city as served by parks, high need for parks, or very high need for parks, was consulted for the level of park access available to St. Louis residents (Figure 70).

This comparison of the Trust for Public Land ParkScore mapping of St. Louis indicated that only small pockets of the city were classified as in high or very high need for parks with most of the city classified as served by parks. Only five percent of publicly owned land parcels were in marginal habitat and three percent in suboptimum habitat, ninety-two percent were in optimum habitat. Though population has left the city, the parks that once served them remain. An assessment of the quality of these parklands was not undertaken. While additional park land may improve the quality of life of residents in areas with high land vacancy, this data demonstrated that an absence of parks was not a major contributing factor to vacancy.

#### **6.2.4.10 Proximity to Views**

Views have been proven to influence real estate prices and it could be reasoned habitat quality. In St. Louis views of the city skyline include the St. Louis arch, and the Mississippi and Missouri Rivers. However, this factor was not considered in this research due to a lack of resources. Well-designed areas of St. Louis may or may not have less vacancy than other areas of the city, but an analysis of this factor was beyond the scope in this research.

#### **6.2.4.11 The Value of Urban Design**

As a city of historic architecture and parks, St. Louis is often used as one of the models of historic urbanism that inspired the New Urbanist movement in the United States. A detailed evaluation of the impact of urban design in the city on publicly owned land vacancy was not possible given available resources.

### **6.2.5 Geophysical Risk**

#### **6.2.1.1 Geology and Vacancy**

In dramatic contrast to New Orleans, the site of St. Louis was shown to be an excellent site for habitation based upon historical ecological conditions. Geophysical risks are minimal. Based upon collapse potential, Ninety-nine percent of publicly owned vacant land parcels in St. Louis are in optimum habitat, none in

suboptimum habitat, and only one percent in marginal habitat. Collapse potential is thus shown to have little influence on land vacancy in St. Louis.

#### **6.2.1.2 Topography, Slope, and Vacancy**

While the bulk of St. Louis occupied a prairie landscape, some of the city was located on rolling loess hills. This soft material is easily shaped by earthwork equipment making it difficult to recreate the original topography condition of the pre-settlement site. The earliest topographic maps appeared after the site was largely modified. Those some portions of the remaining hills are still subject to landslides, topography appears to have presented additional cost of development but was not a fundamental constraint to settlement of the city.

#### **6.2.1.3 Liquefaction and Vacancy**

The potential for liquefaction demonstrated a slightly stronger relationship with land vacancy than collapse and landslide potential. Eighty-seven percent of publicly owned vacant land parcels in St. Louis were in optimum habitat based on liquefaction potential, none in suboptimum habitat, and three percent within marginal habitat. Liquefaction was demonstrated to have little influence on land vacancy in St. Louis (Figure 71).



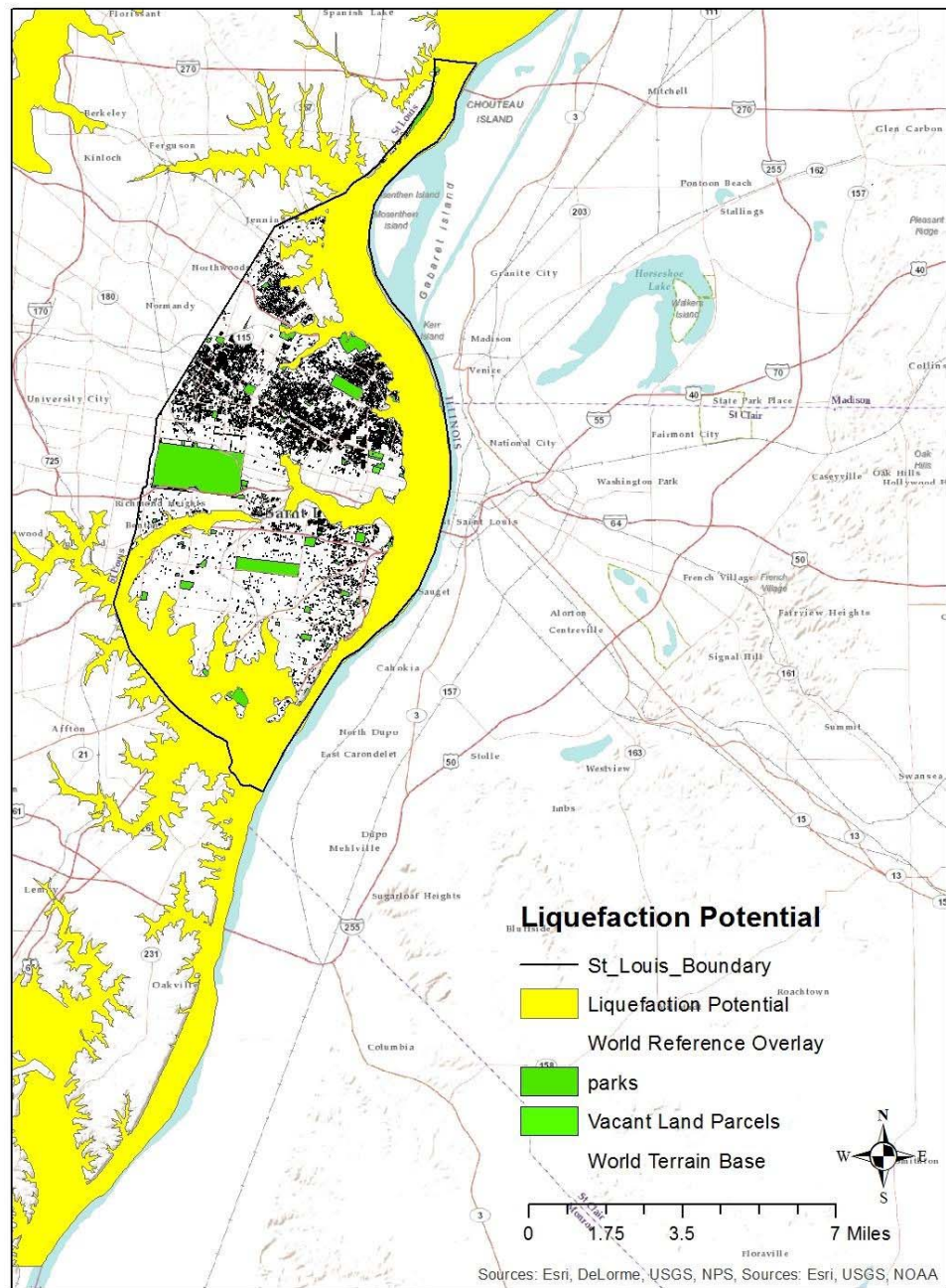


Figure 71: Liquefaction and Vacancy in St. Louis

#### 6.2.1.4 Landslides and Vacancy

Three percent of publicly owned vacant land parcels in St. Louis were found in marginal habitat based upon landslide potential, none in suboptimum, and ninety-seven percent in optimum habitat. This demonstrated that landslide potential had little influence on land vacancy in St. Louis (Figure 72).

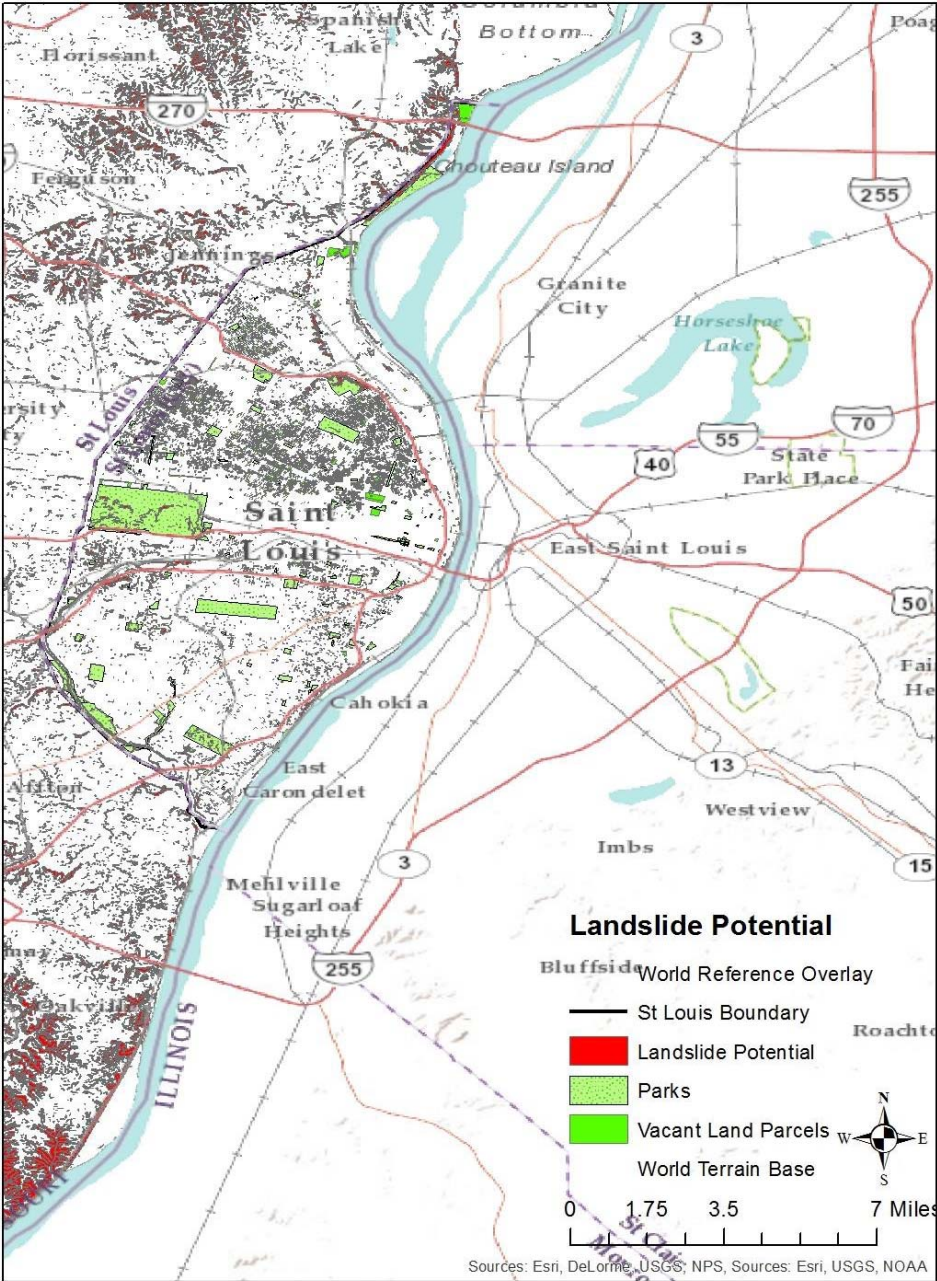
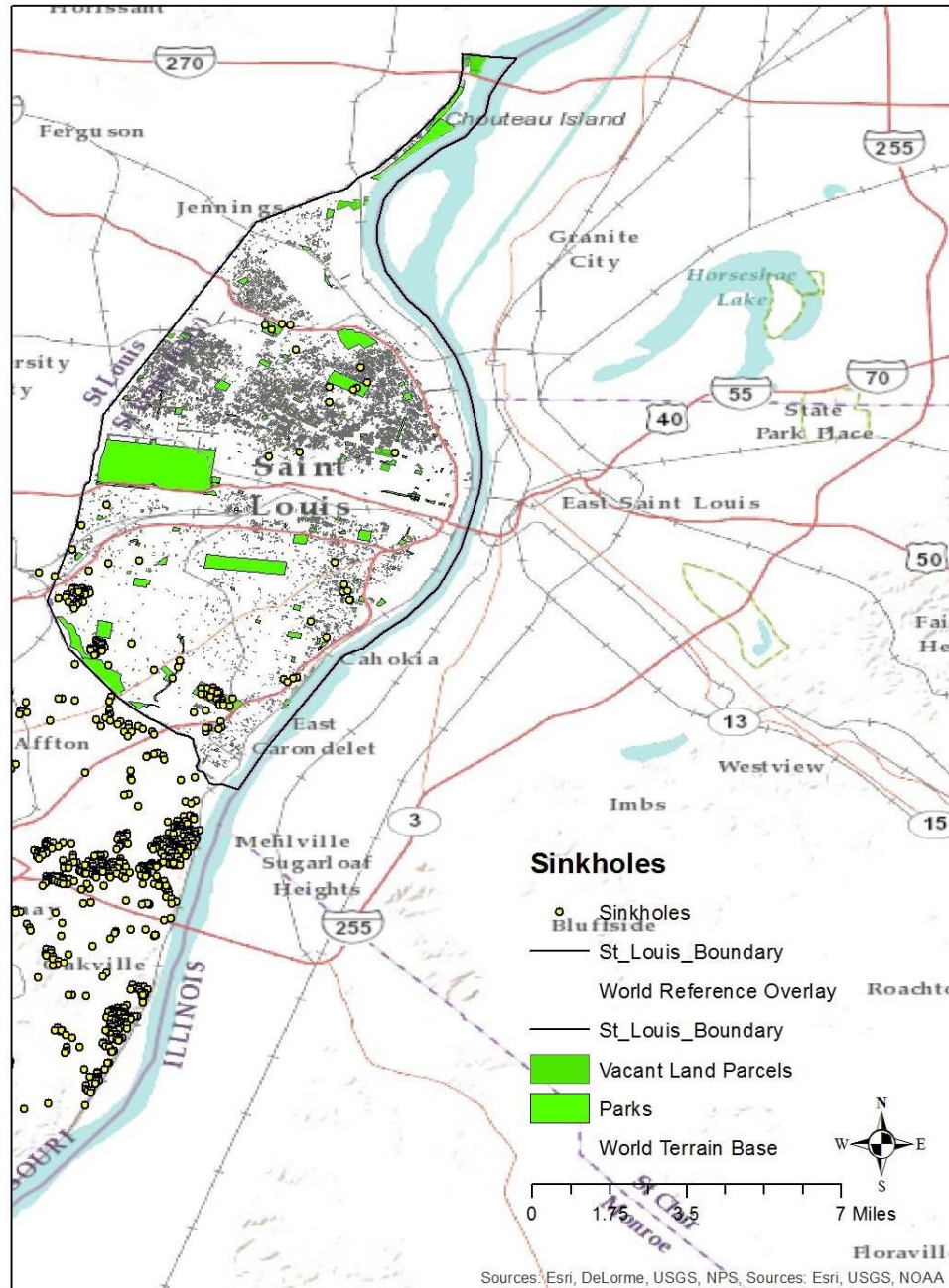


Figure 72: Landslide and Vacancy in St. Louis



### 6.2.1.5 Sinkholes and Vacancy

The limestone karst geology of the St. Louis region provided caves for cooling the city's world-famous beer. It also created sinkholes over the city's history, on occasion swallowing roads and buildings. Because the location on known sinkholes was



only available at point data, analysis of the relationship (Figure 73).

Figure 73: Sinkholes and Vacancy in St. Louis

between sinkholes and land vacancy was difficult. A visual examination of the map below suggested that areas of concentrated vacancy had more sinkholes than other areas of the city but such a conclusion requires ground truthing of the results to confirm this conclusion.

#### **6.2.1.6 Flooding and Vacancy**

Only one percent of publicly owned vacant land parcels in St. Louis was in marginal habitat based upon the potential for flooding while ninety-nine percent was within optimum habitat. Less than one percent of publicly owned vacant land parcels in St. Louis were in marginal habitat based upon conflict with wetlands, none in suboptimum, and almost one hundred percent in optimum habitat. One hundred percent of publicly owned vacant land parcels in St. Louis were on optimum habitat based upon vegetation demonstrating that vegetation has no effect upon land vacancy in St. Louis. When all the scores for geophysical risks are averaged, ninety-seven percent of vacant land parcels in St. Louis were in optimum habitat and three percent in marginal habitat, suggesting that geophysical conditions had very little impact on land vacancy in St. Louis (Figure 74). Geophysical risks have almost no impact on publicly owned land vacancy in St. Louis.

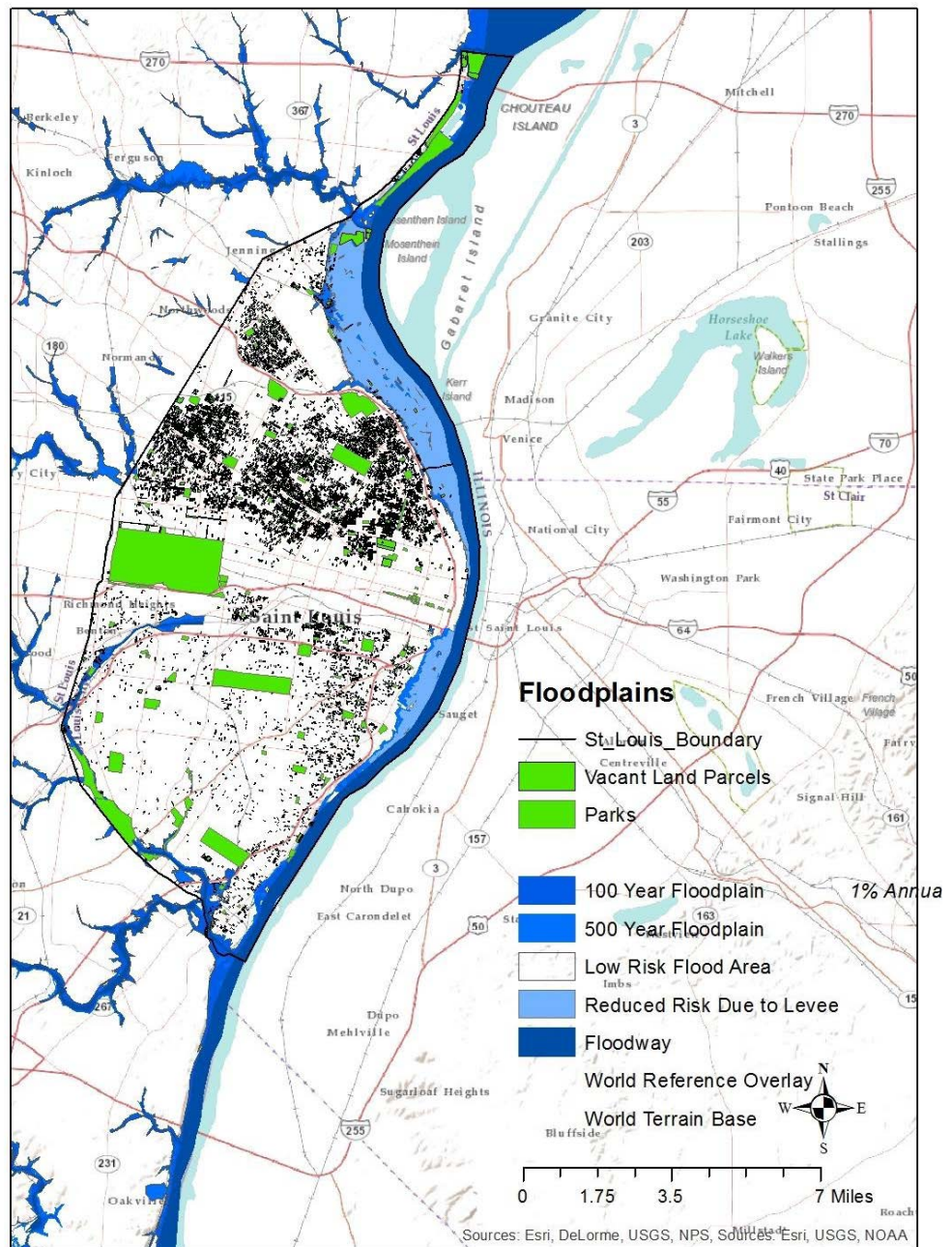
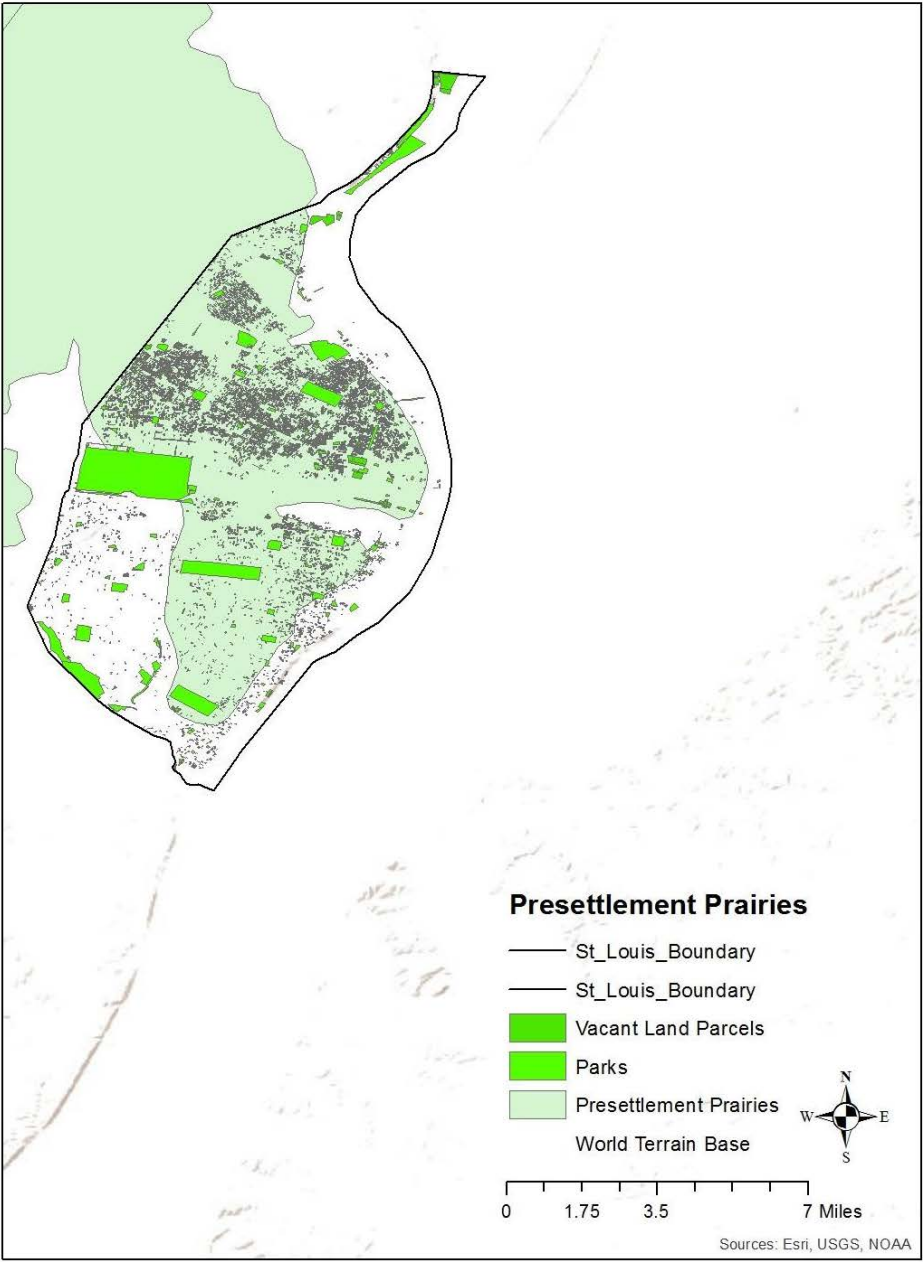


Figure 74: Floodplain and Vacancy in St. Louis

#### **6.2.1.7 Pre-settlement Prairies and Vacancy**

The site of the City of St. Louis was primarily prairies prior to settlement. Almost 100% of publicly owned vacant lots within the city are on land that was prairie prior to European settlement (Figure 75). Whether these prairies were naturally occurring or whether they were created by fires set by Native Americans, who often utilized fire to create habitat for game animals is unknown. While the

relationship of vacancy and these prairies is quite high, no native prairie exist within the city at this time, suggesting that vegetation pattern was not a determinant of



vacancy.

Figure 75: Presettlement Prairies and Vacancy in St. Louis

6.2.1.8 Wetlands and Vacancy



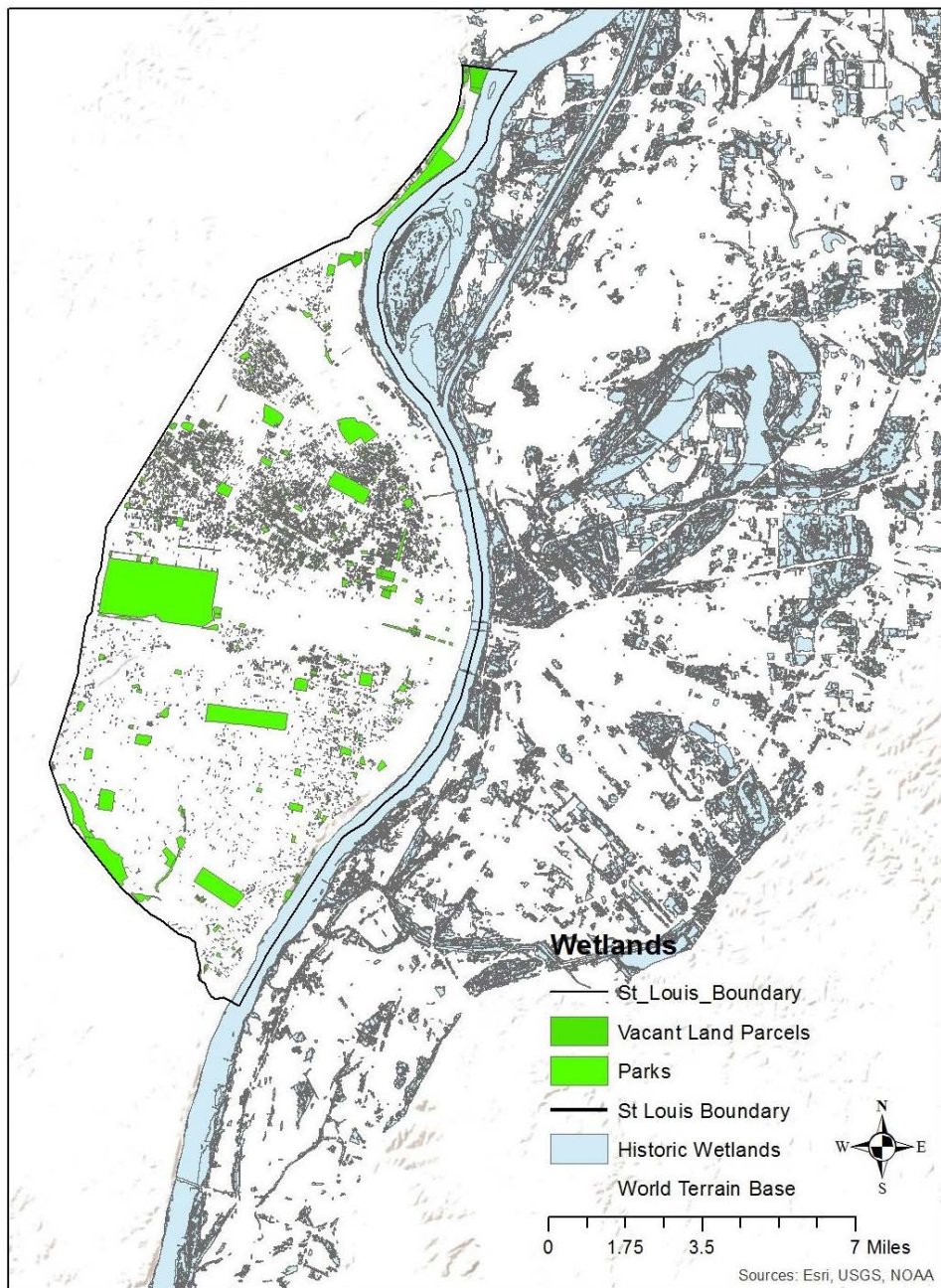


Figure 76: Wetlands and Vacancy in St. Louis

Wetlands were not demonstrated to be a good indicator of publicly owned vacancy in St. Louis. No mapped wetlands remain within the developed limits of the city except for limited areas along the Mississippi River.

Only 22 of the 18,290 publicly owned vacant parcels (.12%) in St. Louis are wetlands or partially wetlands (Figure 76). Wetland data obtained from the East-West Gateway Council of government appears to primarily focus on lands outside the boundaries of the City of St. Louis. One might speculate that there are additional unmapped wetlands within the city limits. Alternatively, it may be that wetlands were removed in the process of developing the city.

#### 6.2.1.9 Tornadoes and Vacancy

Tornadoes are an important part of the disturbance regime of the St. Louis region (Figure 77). However, modeling techniques do not exist to predict the frequency or path of future tornadoes, therefore, tornadoes were not considered a factor in differentiating habitat quality.

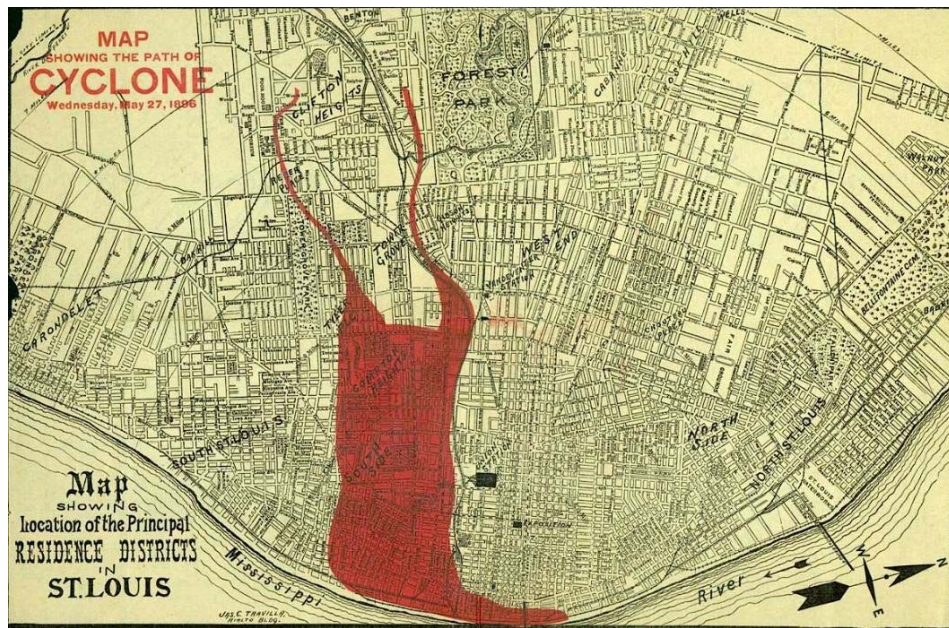


Figure 77: Route of the Tornado of 1893

#### 6.2.6 Social Risk

#### **6.2.6.1 Social Vulnerability and Vacancy**

The Agency for Toxic Substances and Disease Registry (ATSDR) Social Vulnerability Index ranks each census tract based on 14 social factors. These factors were grouped into four themes: Socioeconomic status, household composition, race/ethnicity/language, and housing/transportation. Data was also available for overall social vulnerability (Figure 78).



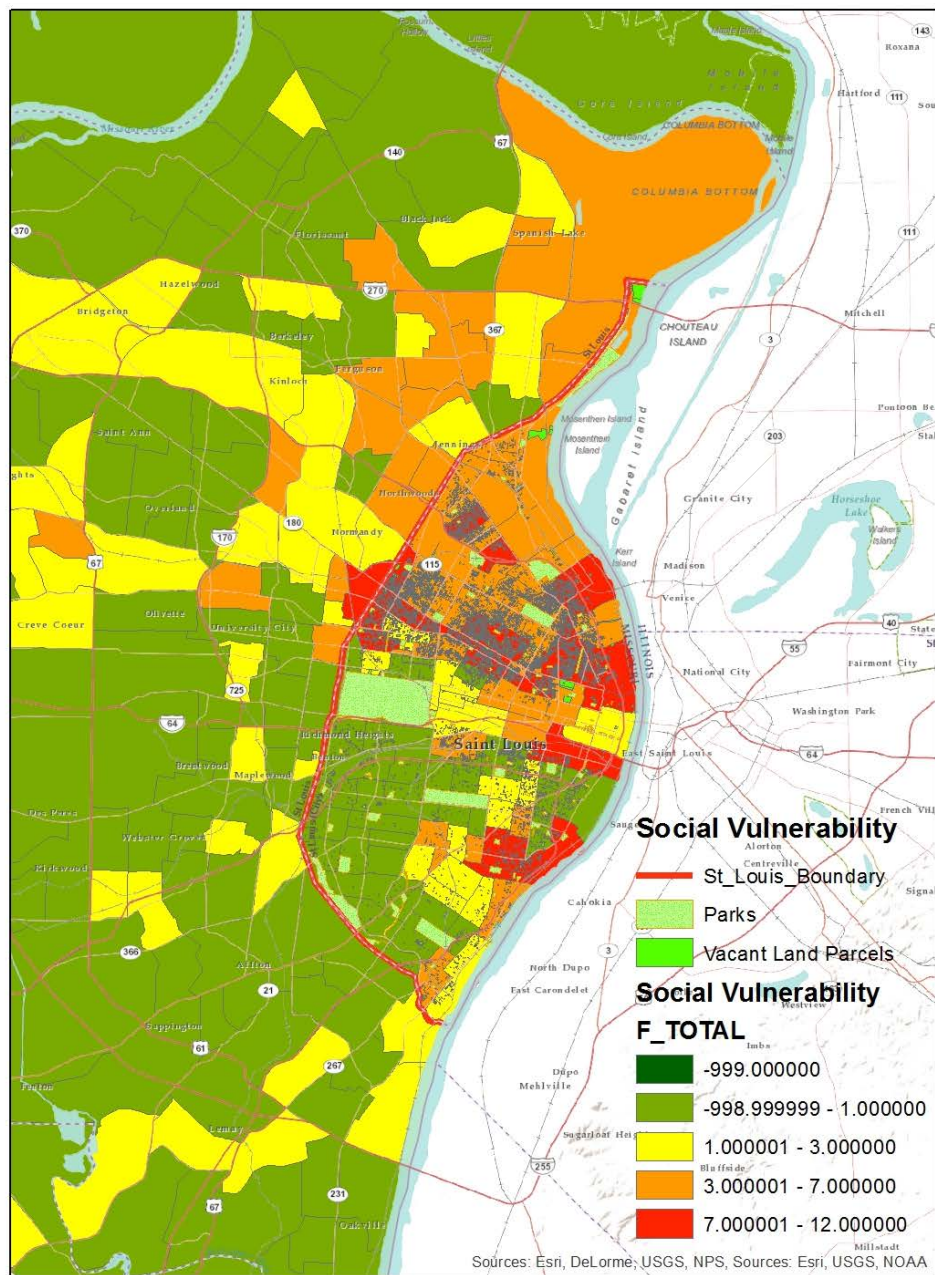


Figure 78: Total Social Vulnerability and Vacancy in St. Louis

A map layer of vacant land parcels in St. Louis was overlay over map layers for each of these themes. Two percent of publicly owned vacant land parcels were within optimum habitat based upon socio-economic factors, eight in suboptimum, and ninety percent in marginal habitat.

Based upon housing composition and diversity, nine percent were within optimum habitat, fifteen percent within suboptimum, and seventy-six percent in marginal habitat (Figure 79).

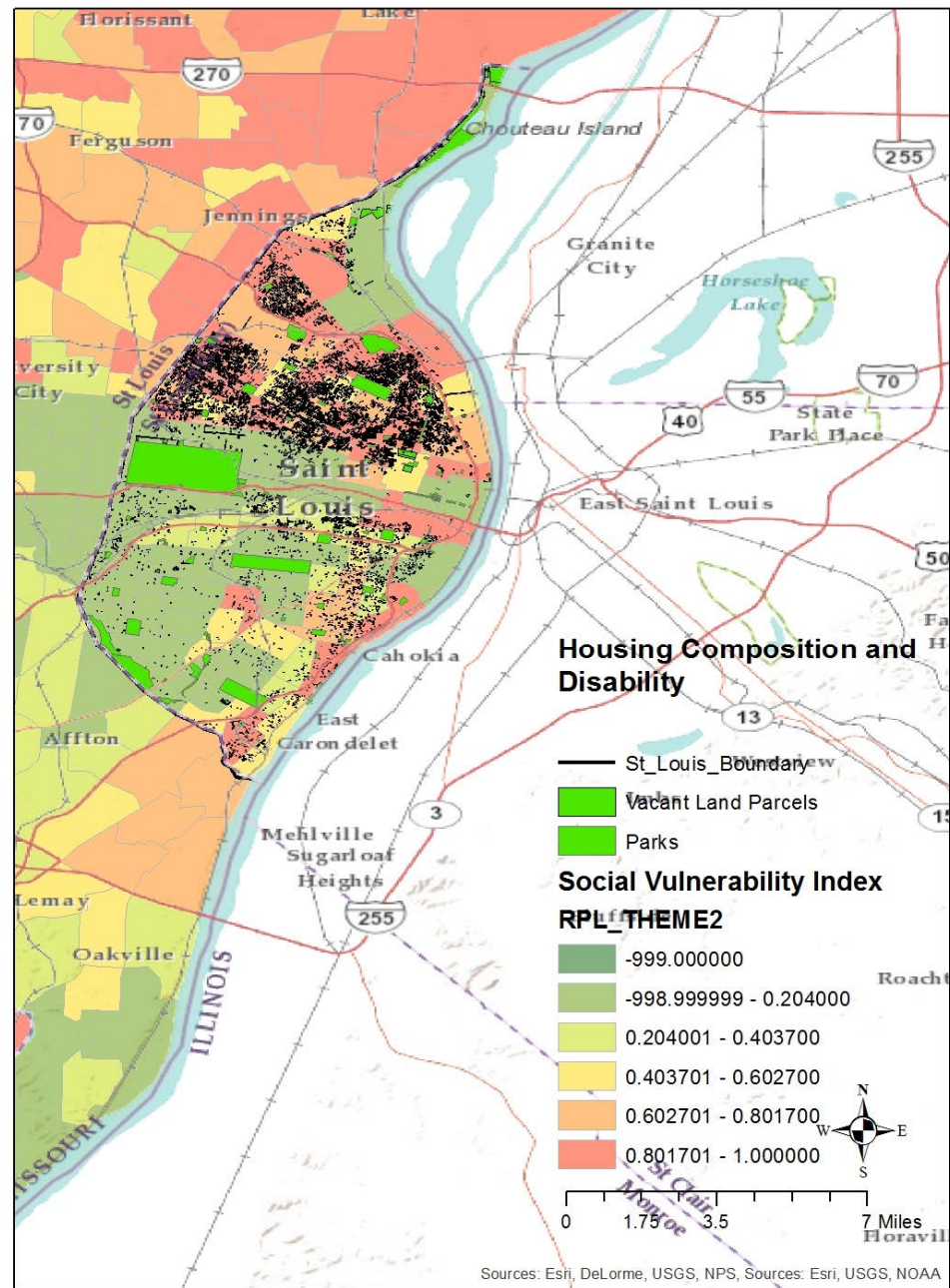


Figure 79: Housing Composition and Disability and Vacant Lands in St. Louis



A review of the map layer for minority population and language found that none of the publicly owned vacant land parcels were within optimum habitat, sixty-one percent within suboptimum habitat, and thirty-nine percent within marginal habitat (Figure 80).

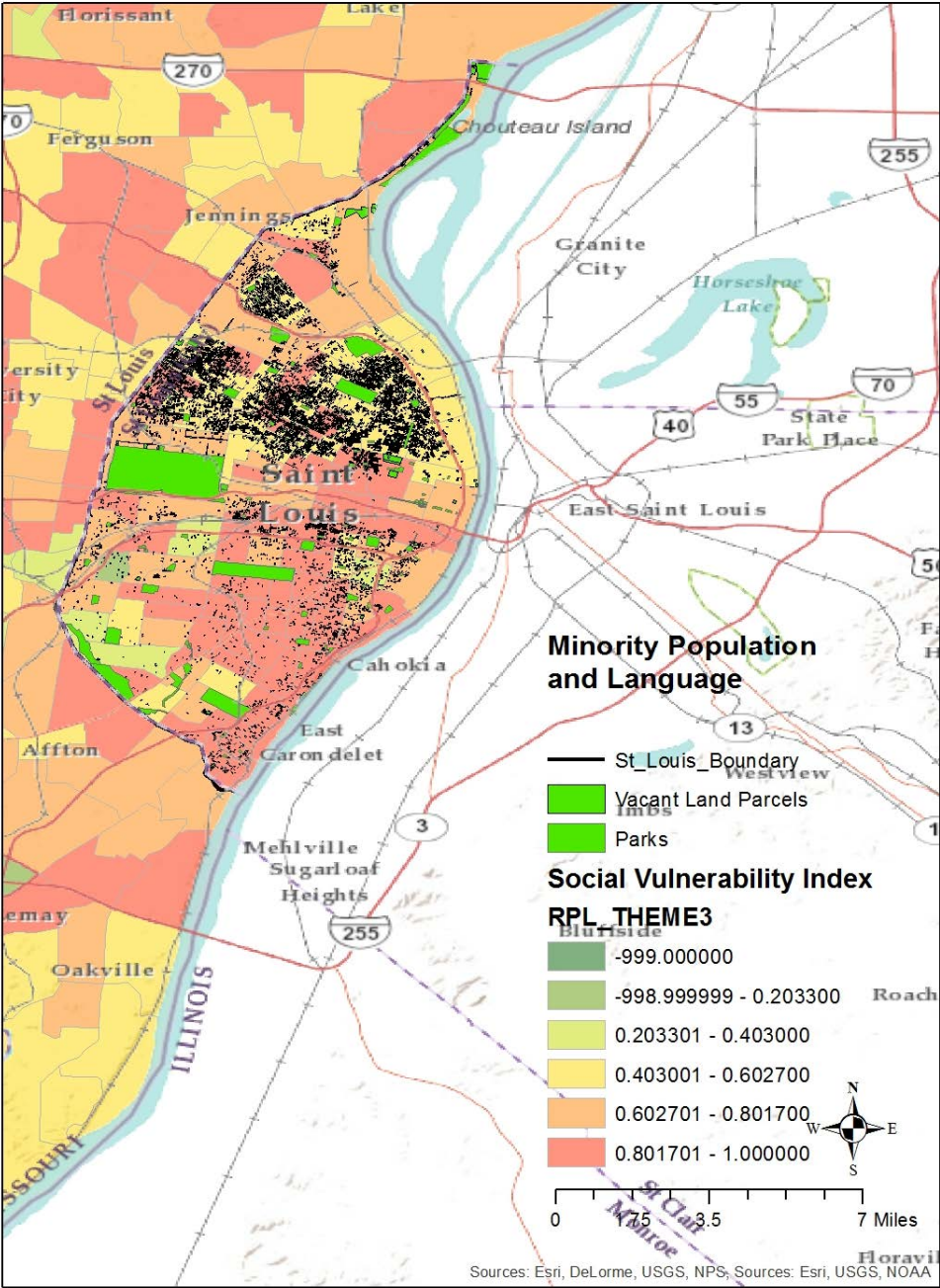


Figure 80: Minority Population, Language, and Vacant Land in St. Louis

The map layer for housing and transportation, demonstrated that seven percent of vacant land parcels were within optimum habitat, twenty percent within suboptimum, and seventy-three percent within marginal habitat (Figure 81).

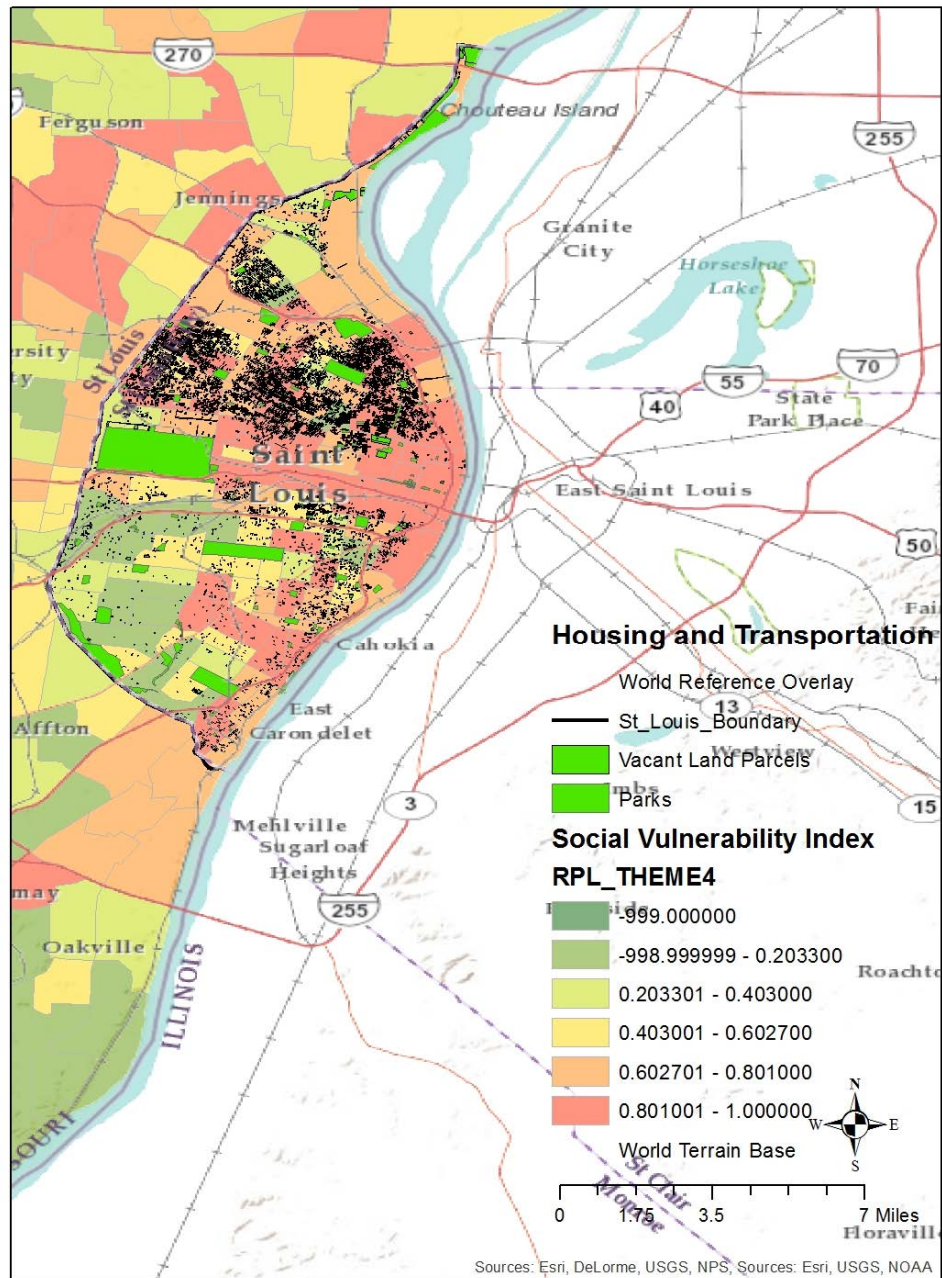


Figure 81: Housing, Transportation, and Land Vacancy in St. Louis

#### **6.2.6.1 Race and Vacancy**

While race is not considered a social risk, it may nonetheless be considered an indicator of publicly owned land vacancy. The racial composition of St. Louis was examined in three ways. First, a data layer of vacant land parcels was laid over a data layer illustrating the percentage of African American population (the largest racial minority in the city). Seventy-six percent of the vacant land parcels in St. Louis are found in the third of census tracts with the highest percentage of African-American residents, twenty-one percent in the third of census tracts, and only three percent in the census tracts with the lowest percentage of African-American residents. It can be concluded, therefore, that publicly owned land vacancy is highly related to race (Figure 82) .

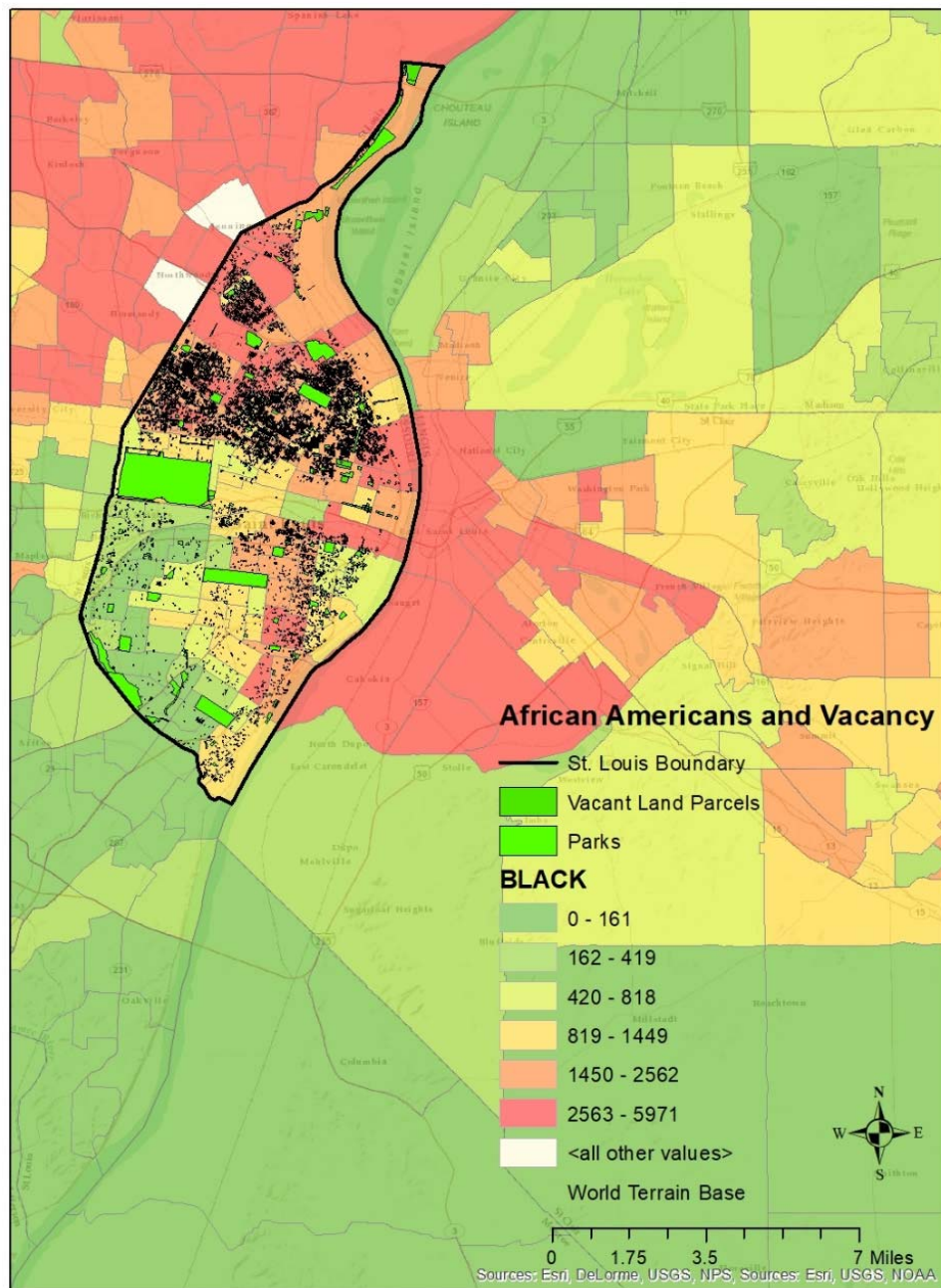


Figure 82: African Americans and Vacancy in St. Louis

#### 6.2.6.2 The Diversity Index



The Diversity Index is examined to determine the relationship between racial diversity and land vacancy. For this study, a higher level of diversity is assumed to improve habitat (Figure 83). Twenty-eight percent of vacant land parcels were found within optimum habitat, the most diverse areas of the city. Twenty-two percent were found in suboptimum habitat. Fifty percent of vacant land parcels were found in marginal areas of the city based upon the diversity index. This study suggests that land vacancy is generally inversely related to diversity, that is, the higher the level of racial similarity the greater the level of land vacancy.

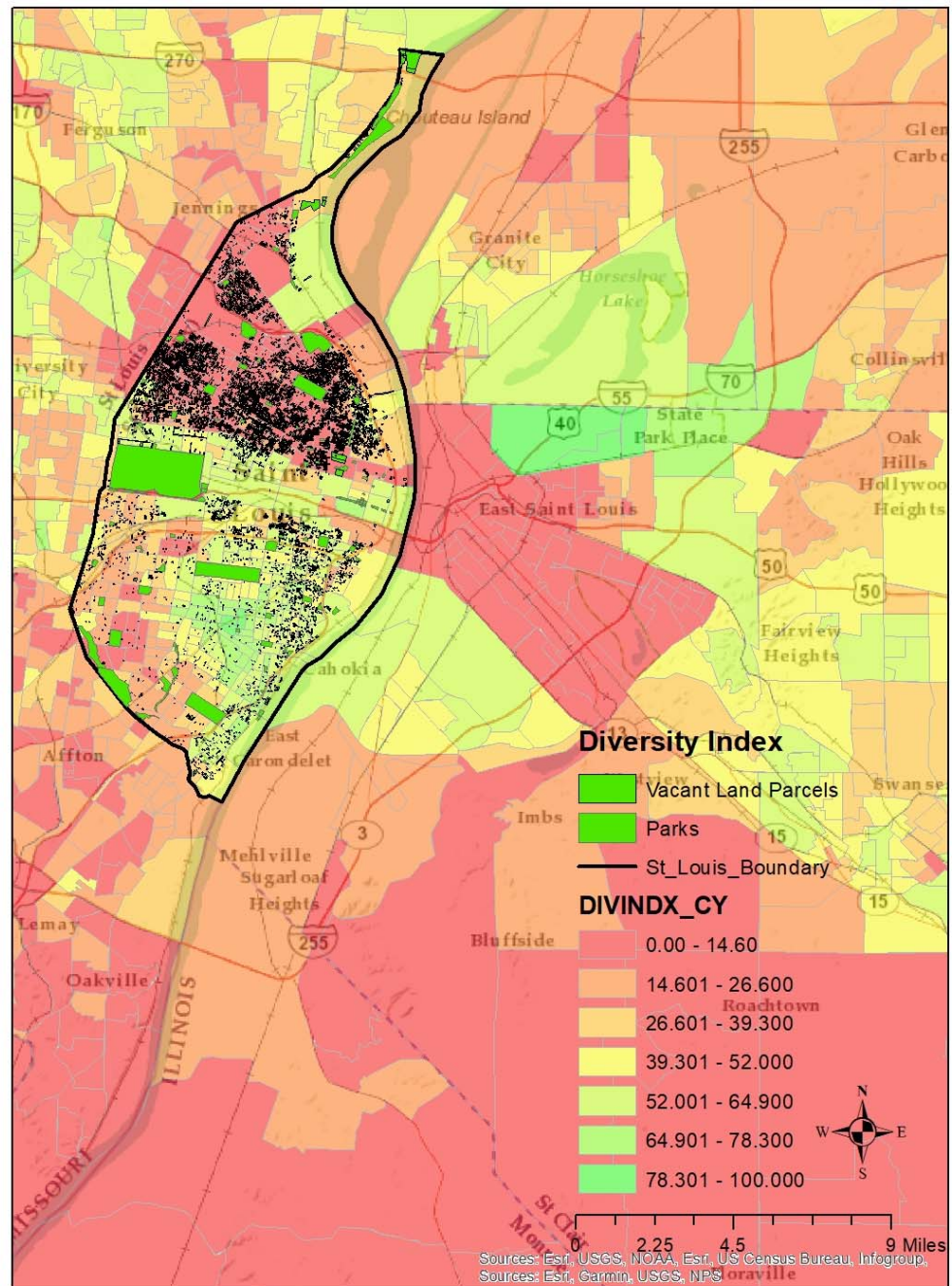


Figure 83: The Diversity Index and Land Vacancy in St. Louis

### 6.2.6.3 Racial Covenants and Vacancy



Racial covenants in St. Louis were mapped and overlaid with a data layer of vacant land parcels. Although the covenants covered only a limited portion of the city, they had the impact of helping to concentrate the African-American population of the city in the Near North Side. Eighteen percent of the publicly owned vacant land parcels in the city are in areas that were subject to racial covenants (Figure 84).

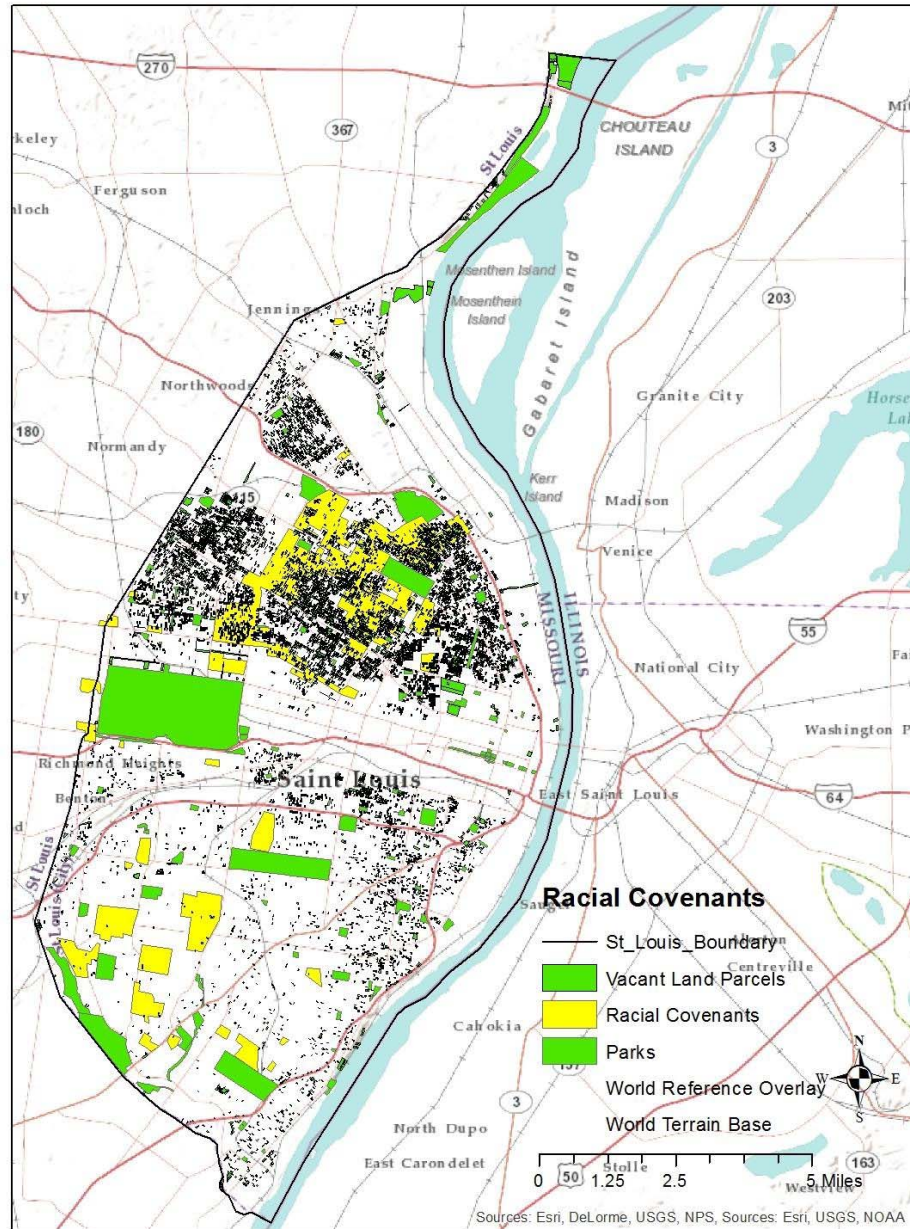


Figure 84: Racial Covenants and Vacancy in St. Louis

#### 6.2.6.4 Redlining and Vacancy

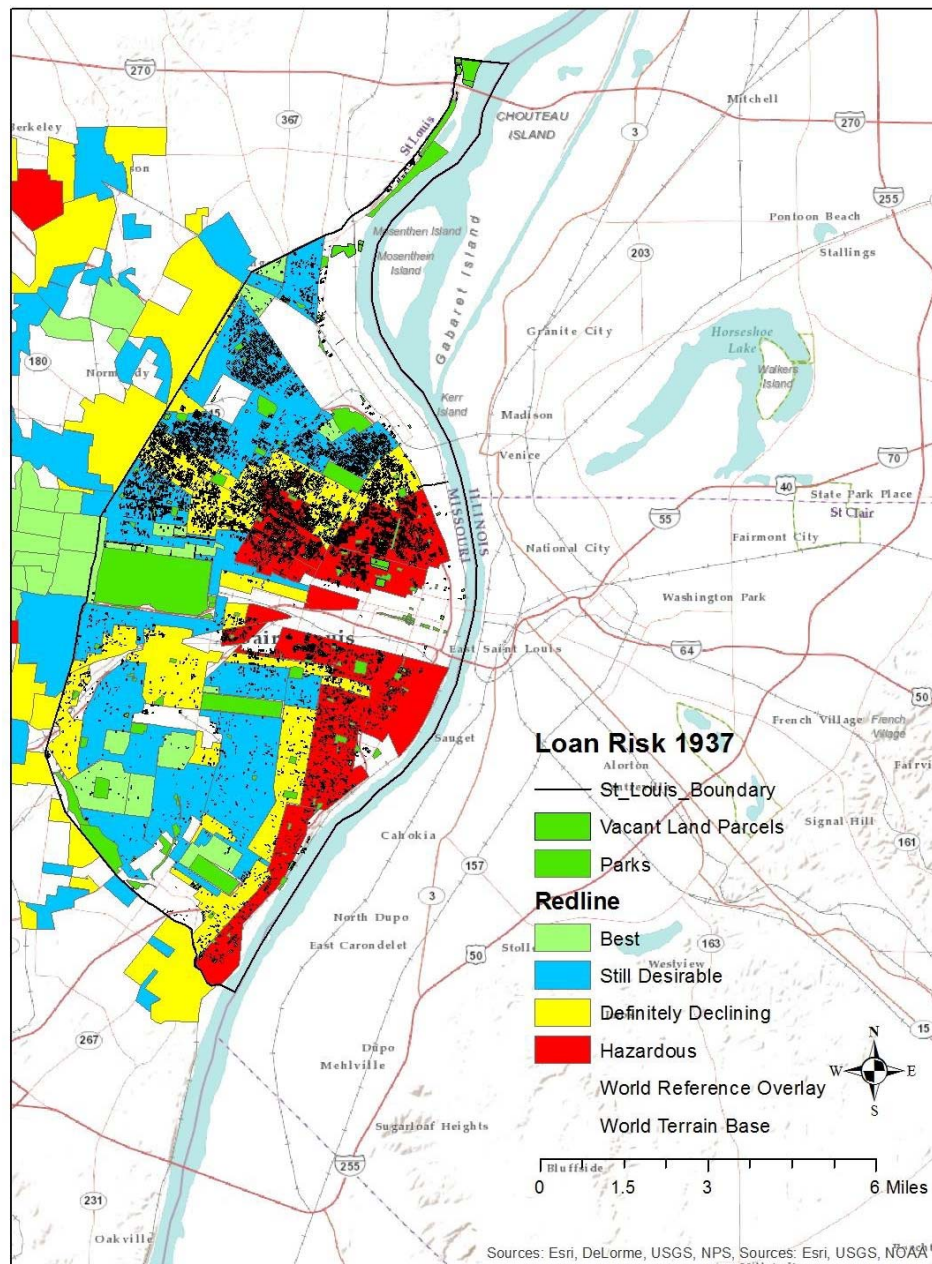


Figure 85: Loan Risk (Redlining) in St. Louis

Redlining was a practice sanctioned by the Home Owner's Loan Corporation of the United States from 1937 until the passage of the Fair Housing Act in 1968. Under this program areas of a city were classified as best, still desirable,

definitely declining, and hazardous. Seventy-percent of publicly owned vacant land parcels in St. Louis are in areas classified as hazardous in 1937. Twenty-nine percent were in areas classified as definitely declining and only one percent in areas classified as best or still desirable (Figure 85). Numerous studies have confirmed the negative effects of this program which persist today.



### 6.2.6.5 Urban Renewal and Vacancy

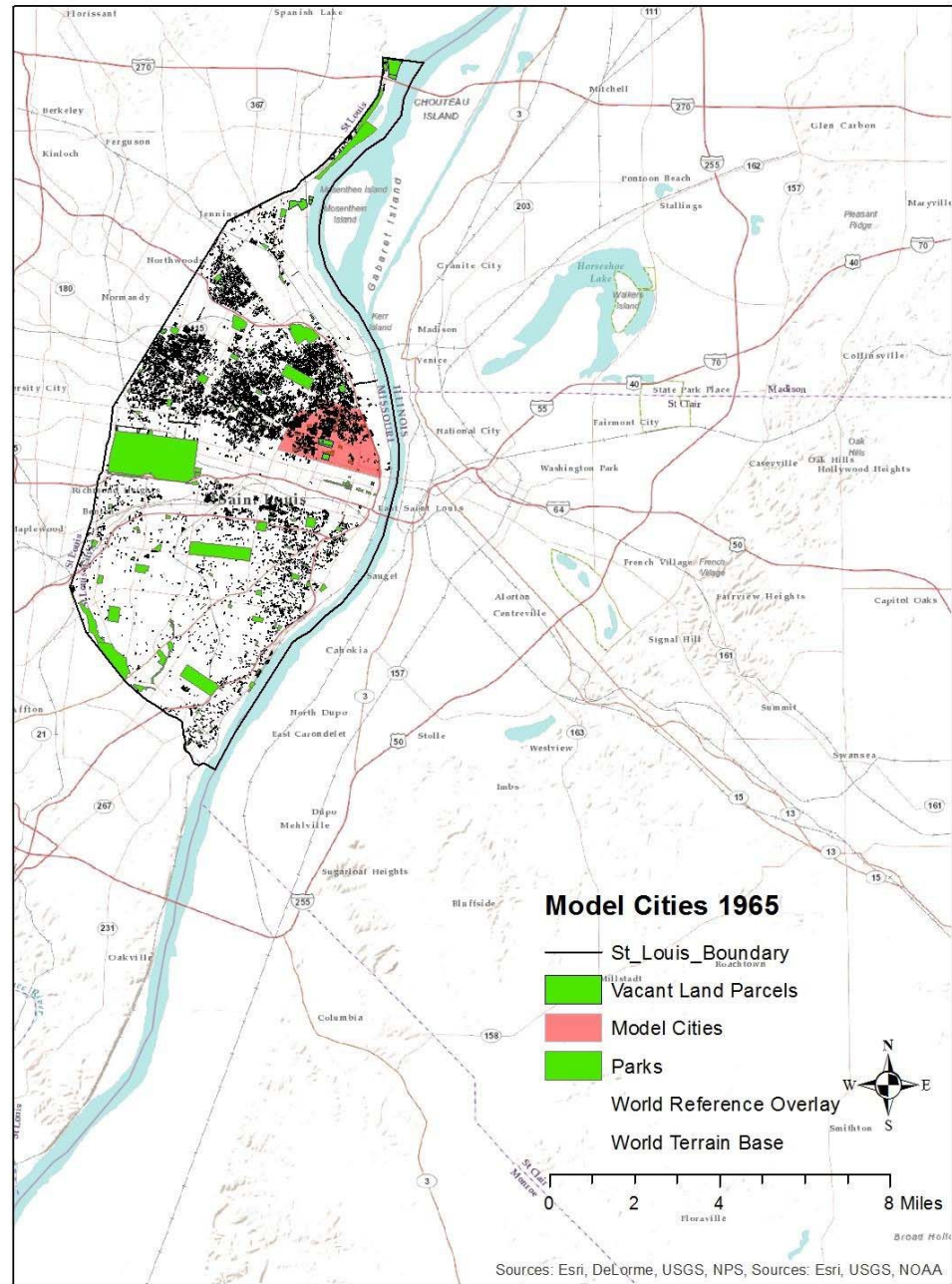


Figure 85: Model Cities 1965 (Urban Renewal Program) and Vacancy in St. Louis

Slum clearance was a major strategy for elected and appointed officials in many American cities through the 1950s and 1960s. These programs included the Model Cities program of 1965. Fifty-eight percent of publicly owned vacant land parcels in St. Louis today are in areas considered marginal due to their urban renewal strategies. Fourteen percent are found in suboptimum and twenty-eight percent in optimum (Figure 86). Simply put much of the publicly owned vacant lands in St. Louis are vacant because they were consciously cleared by city leaders.

#### 6.2.6.6 Public Housing Projects and Vacancy

Numerous public housing projects have been constructed in St. Louis in an attempt to provide housing to city residents (Figure 87). Almost all of these are on the Near North Side. The most infamous of these Pruitt-Igoe was demolished and remains publicly owned vacant land today.

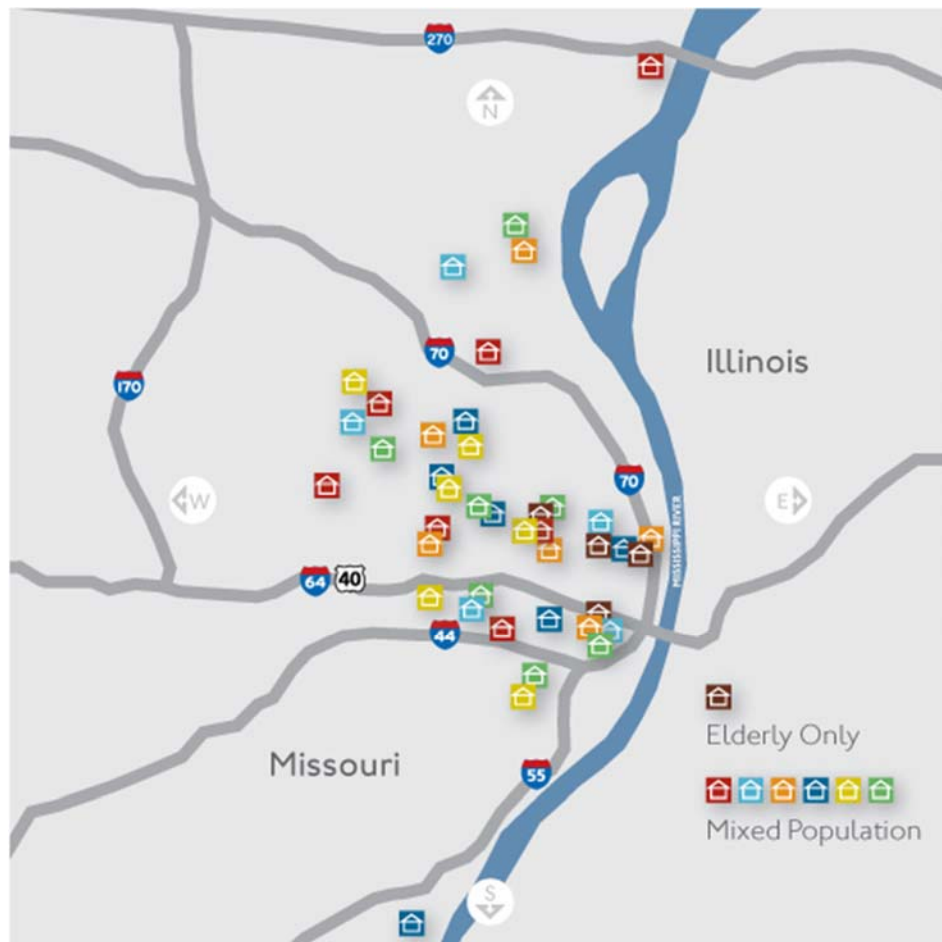


Figure 87: Public Housing Projects in St. Louis

### 6.2.6.7 Neighborhood Effects and Vacancy

Poverty, crime, and other factors included in this research contribute to neighborhood effects in St. Louis.

### 6.2.6.8 Median Household Income and Vacancy

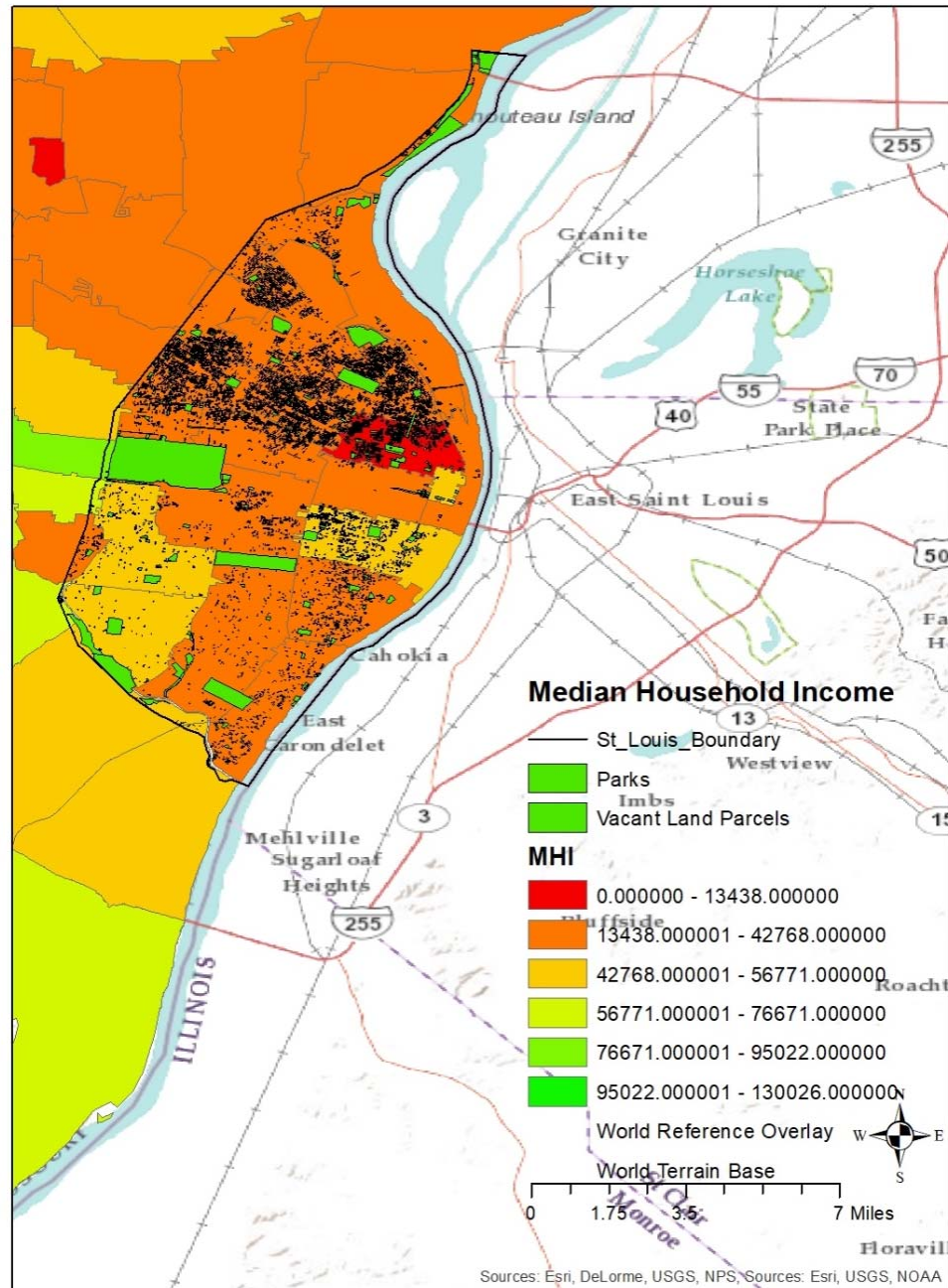


Figure 88: Median Home Values and Vacancy in St. Louis

Seventeen percent of publicly owned vacant land parcels in St. Louis were found within optimum habitat (the upper one third of median home values). Fourteen percent within the middle third of median home values (suboptimum habitat), and seventy-three percent with marginal habitat (the lower one third of median home values) (Figure 88). It was demonstrated that vacant land parcels that are distant from opportunities and in close proximity to social and technological risk, and that these lands are highly related to areas of lower median home values.

#### **6.2.6.9 Poverty and Vacancy**

Eighty-nine percent of publicly owned vacant land parcels in St. Louis are in marginal habitat. Six percent are in suboptimum habitat and five percent in optimum habitat.

#### **6.2.6.10 Unemployment and Vacancy**

Although unemployment contributes to poverty, this factor and its relationship to publicly owned land vacancy was not examined as part of this research.

#### **6.2.6.11 Home Tenure and Vacancy**



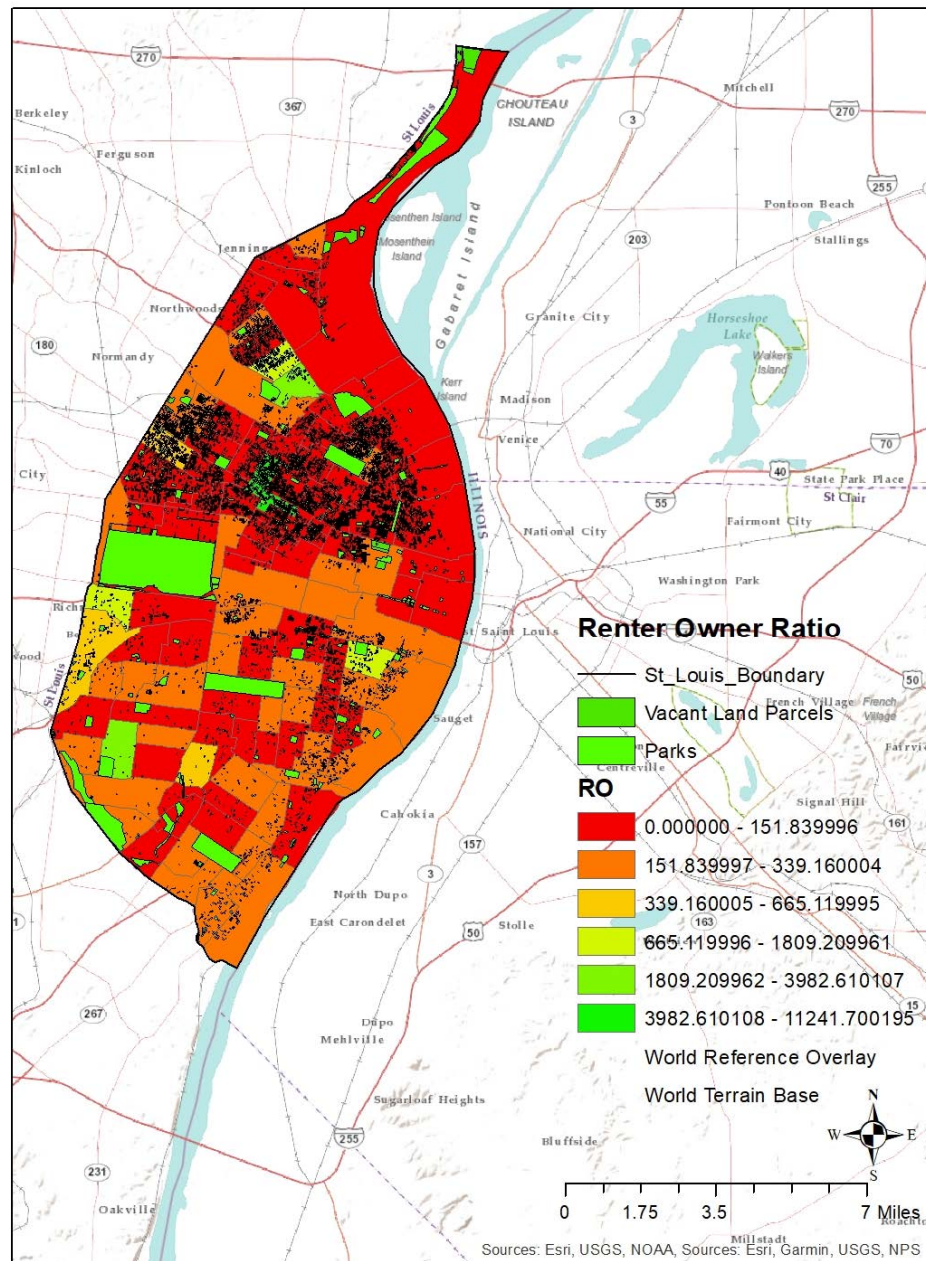


Figure 89: Home Tenure and Vacancy in St. Louis

Home tenure is one measure of neighborhood stability. Eighty-nine percent of the publicly owned vacant land parcels in St. Louis are in marginal habitat. Six percent are in suboptimum habitat and five percent in optimum habitat (Figure 89).



#### 6.2.6.12 Crime and Vacancy

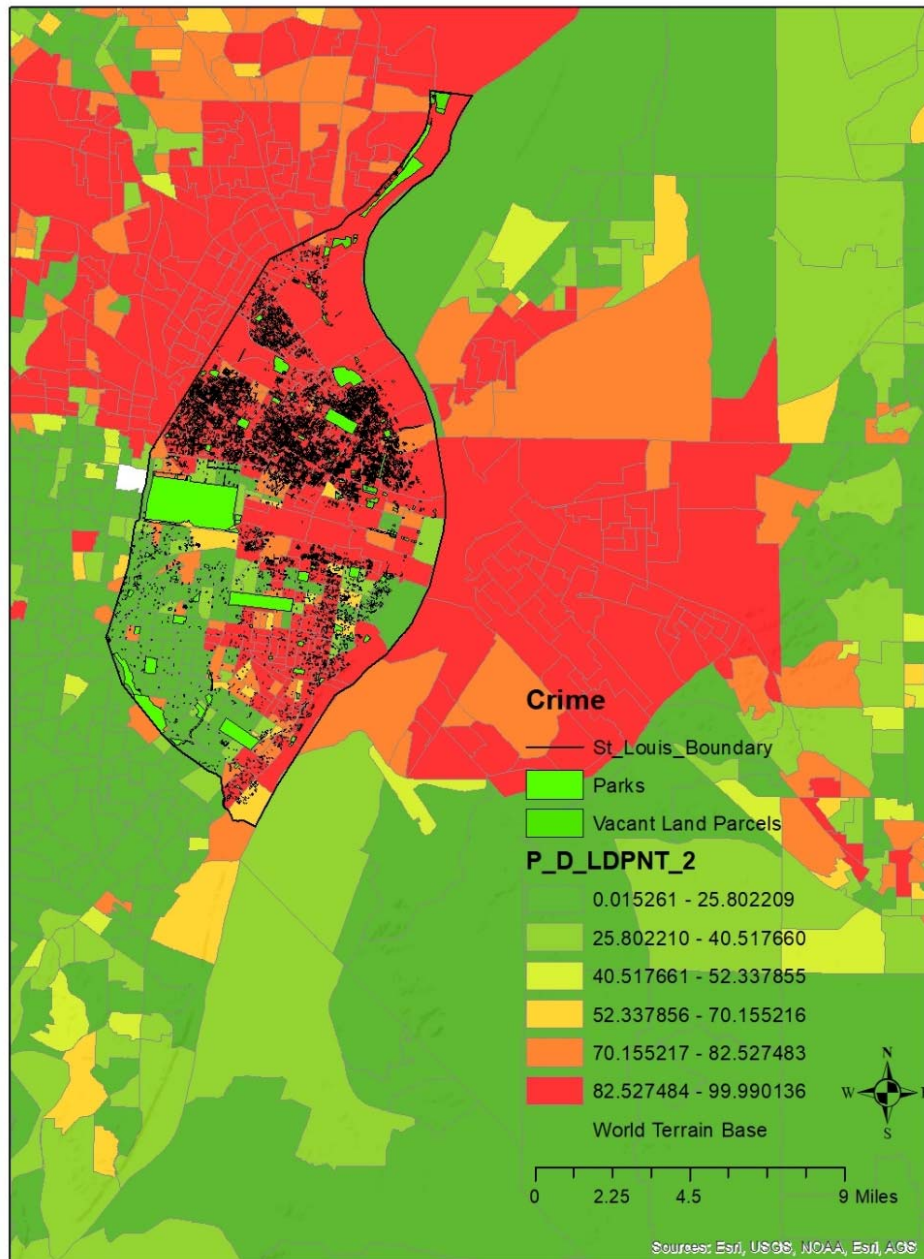


Figure 90: Crime and Vacancy in St. Louis

Crime data is available on a census tract basis from the United States Crime Index from ESRI Online, but does not allow a calculation of the percentage of publicly owned vacant land in optimum, suboptimum, or marginal habitat. Clearly

the vast majority of publicly owned vacant land parcels are in the areas of highest crime in the city. Only a visual examination of the map is possible (Figure 90). As crime has been shown to be a portion of the neighborhood effects that can influence property values it is clearly a factor in vacancy. Additional research is needed to determine how the magnitude of crime in a given area and the presence of different kinds of criminal acts influence land vacancy.

#### **6.2.6.13 Historic Districts**

Some management activities may help to reduce vacancy. The relationship between historic districts and vacancy, for example, is an interesting one. As in New Orleans, one can see that the presence of an historic district in St. Louis generally was not found to have a strong relationship with vacancy, but there are exceptions (Figure 91). One might speculate that healthy neighborhoods with higher incomes and a high level of social capital seek historic district designation due to neighborhood pride or an interest in neighborhood preservation. Lower income neighborhoods perhaps lack the motivation to seek such designation or their residents have more pressing concerns.

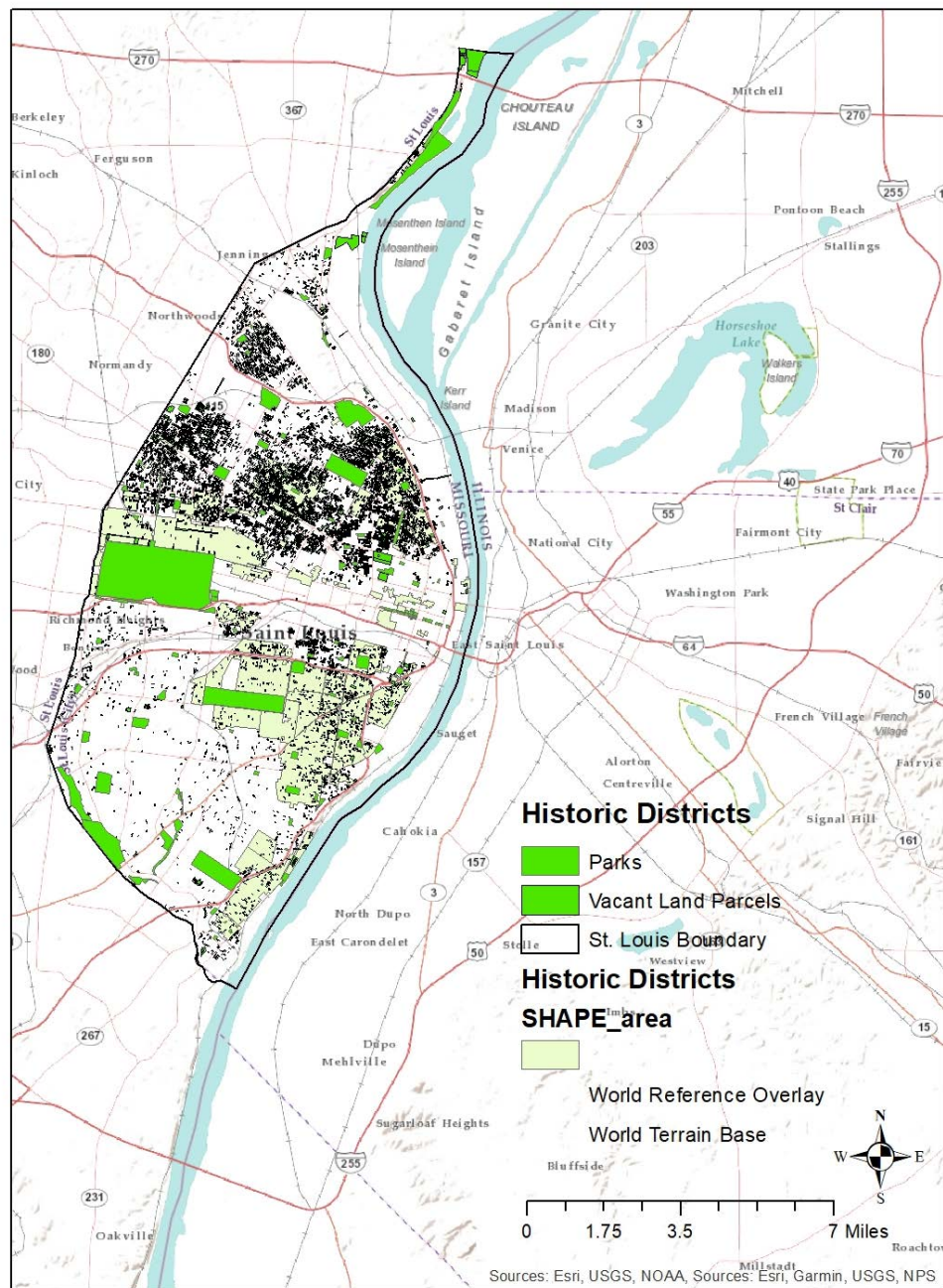


Figure 91: Historic Districts and Publicly owned Vacant Lands in St. Louis

### **6.2.7 Technology Risk**

Technological risks in St. Louis were demonstrated to have significant relationship with land vacancy. One hundred percent of publicly owned vacant land parcels in St. Louis were located in marginal habitat based upon cancer risk and for diesel particulate matter and respiratory risk. The proximity to the Near North Side of St. Louis to the city's major industrial areas are likely the cause of this relationship. Eighty-seven percent of publicly owned vacant land parcels are in marginal habitat based upon proximity to regulated storage and disposal facilities (TSDF sites) and proximity to Risk Management Plan (RMP) sites. The latter are sites with potential for chemical accidents. Thirteen percent of publicly owned vacant land parcels are in optimum habitat based upon these sites and none within suboptimum habitat. Eighty-two percent of publicly owned vacant land parcels in St. Louis are in marginal habitat based upon proximity to superfund sites (NPL) and thirteen percent in suboptimum habitat. None were in optimum habitat. Seventy-eight percent of publicly owned vacant land parcels in St. Louis are in marginal habitat based upon proximity to water discharge sites and twenty-two percent within suboptimum habitat. None were in optimum habitat. As in New Orleans, traffic impacts were shown to be less of an influence on land vacancy than the absence of opportunity or proximity to major pollution sources. Forty-nine percent of publicly owned vacant land parcels in St. Louis were in marginal habitat based upon proximity to traffic, thirty-three percent in suboptimum habitat, and eighteen percent in optimum habitat.

Based upon an average of all technological risks, eighty-eight percent of the publicly owned vacant land parcels in St. Louis were located in marginal habitat, ten percent in suboptimum habitat, and only two percent in optimum habitat.



### 6.2.7.1 Proximity to Traffic and Vacancy

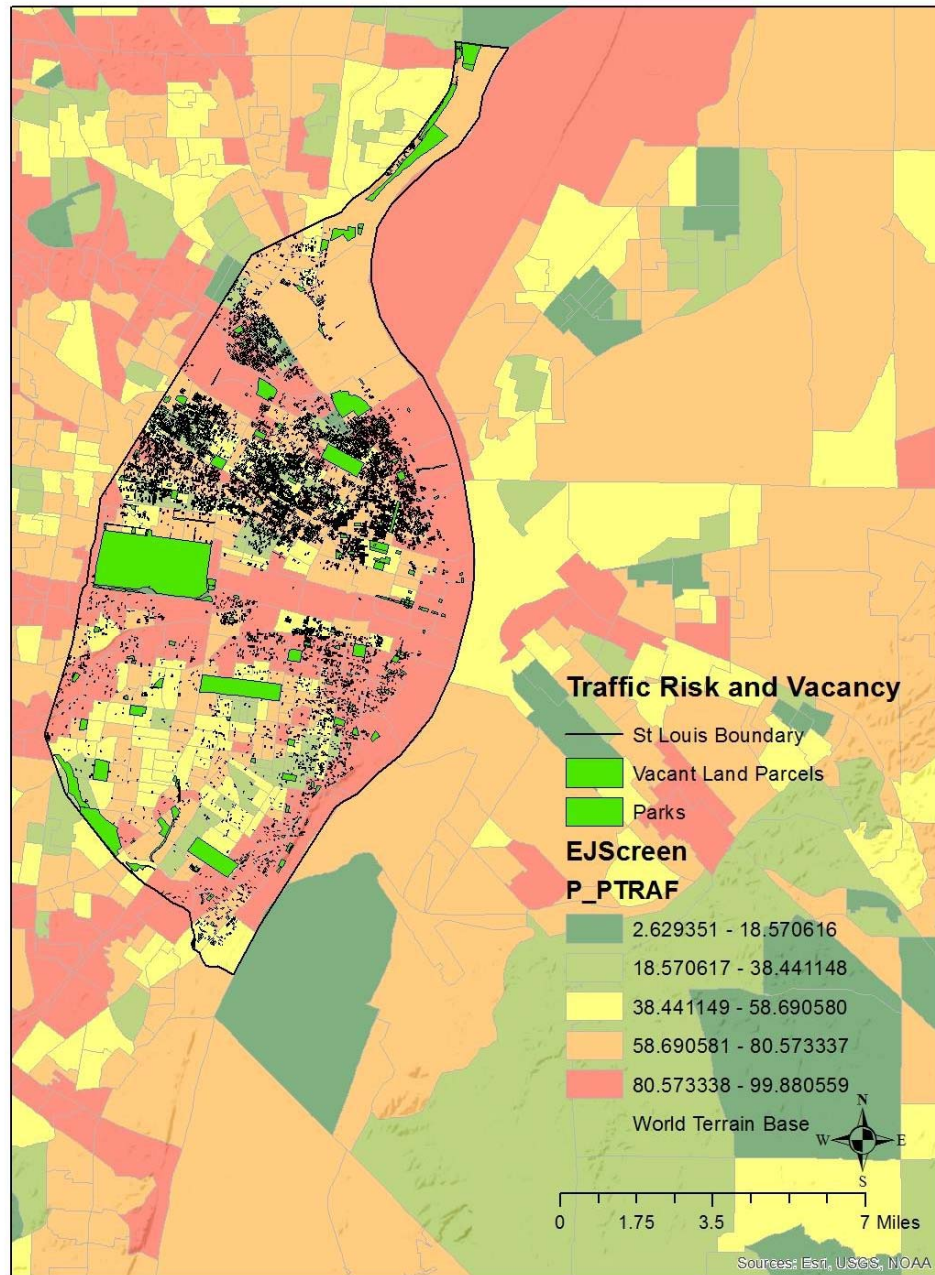


Figure 91: Traffic Risk and Vacancy in St. Louis

#### **6.2.7.2 Proximity to Railroads and Vacancy**

The construction of railroads in the Mill Creek Valley follow the gentle grade of Mill Creek. While urban renewal cleared hundreds of homes of African-Americans during the 1960s, these lots are not longer vacant as they have been utilized for industrial development along the railroad lines.

#### **6.2.7.3 Proximity to High Voltage and Transmission Lines and Vacancy**

High voltage and transmission lines were not found to be a contributing factor to land vacancy in St. Louis.

#### **6.2.7.4 Proximity to Landfills and Waste Incinerators and Vacancy**

Sufficient data was not available to determine the impact of landfills and waste incinerators on land vacancy in St. Louis.

#### 6.2.7.5 Proximity to Cancer Risk and Vacancy

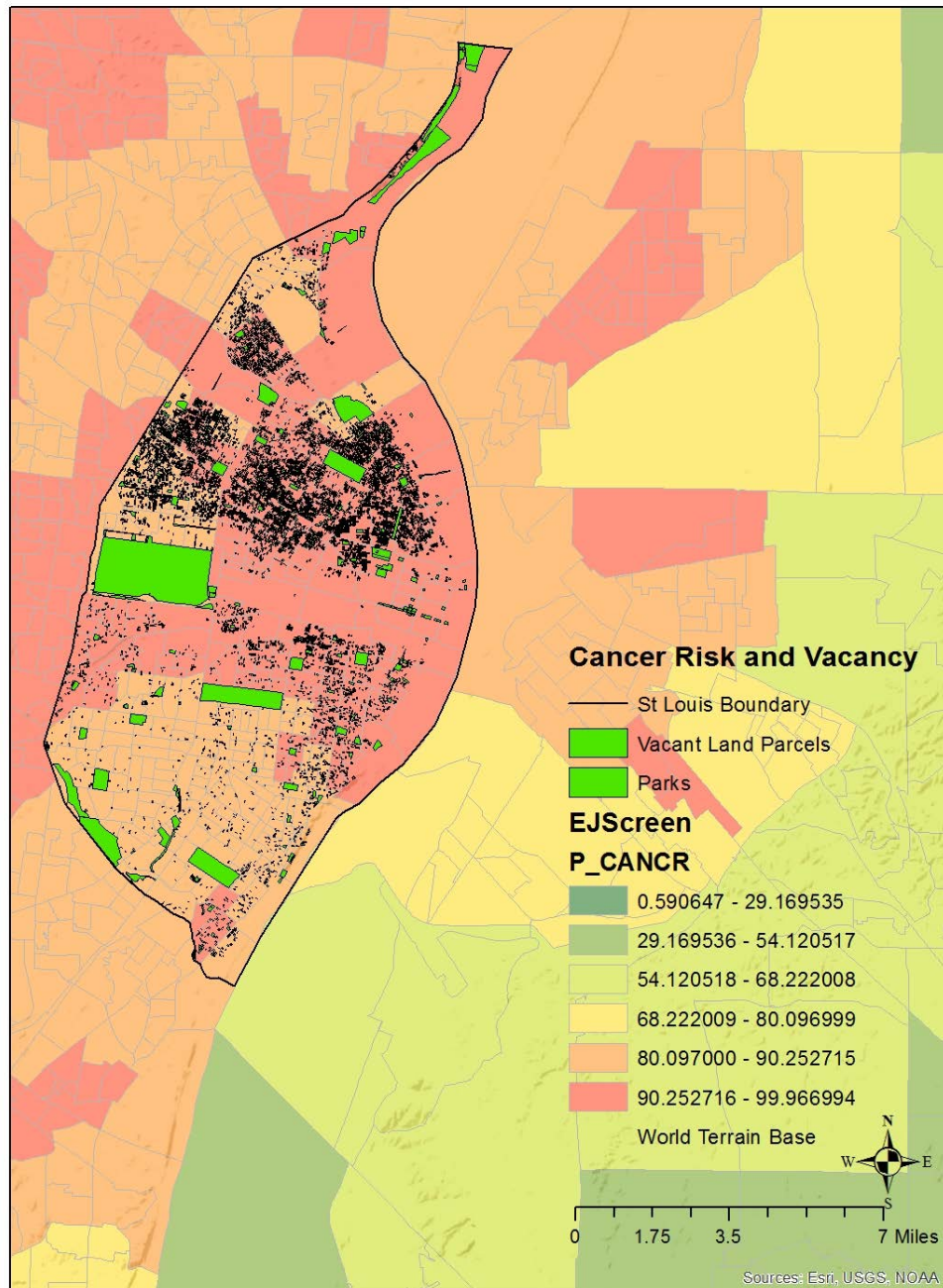


Figure 93: Cancer Risk and Land Vacancy in St. Louis

One hundred percent of vacant land parcels in St. Louis are in marginal habitat based upon cancer risk in St. Louis.



### 6.2.7.6 Proximity to Respiratory Hazard and Vacancy

One hundred percent of publicly owned vacant land parcels in St. Louis are in marginal habitat based upon respiratory hazard (Figure 94).

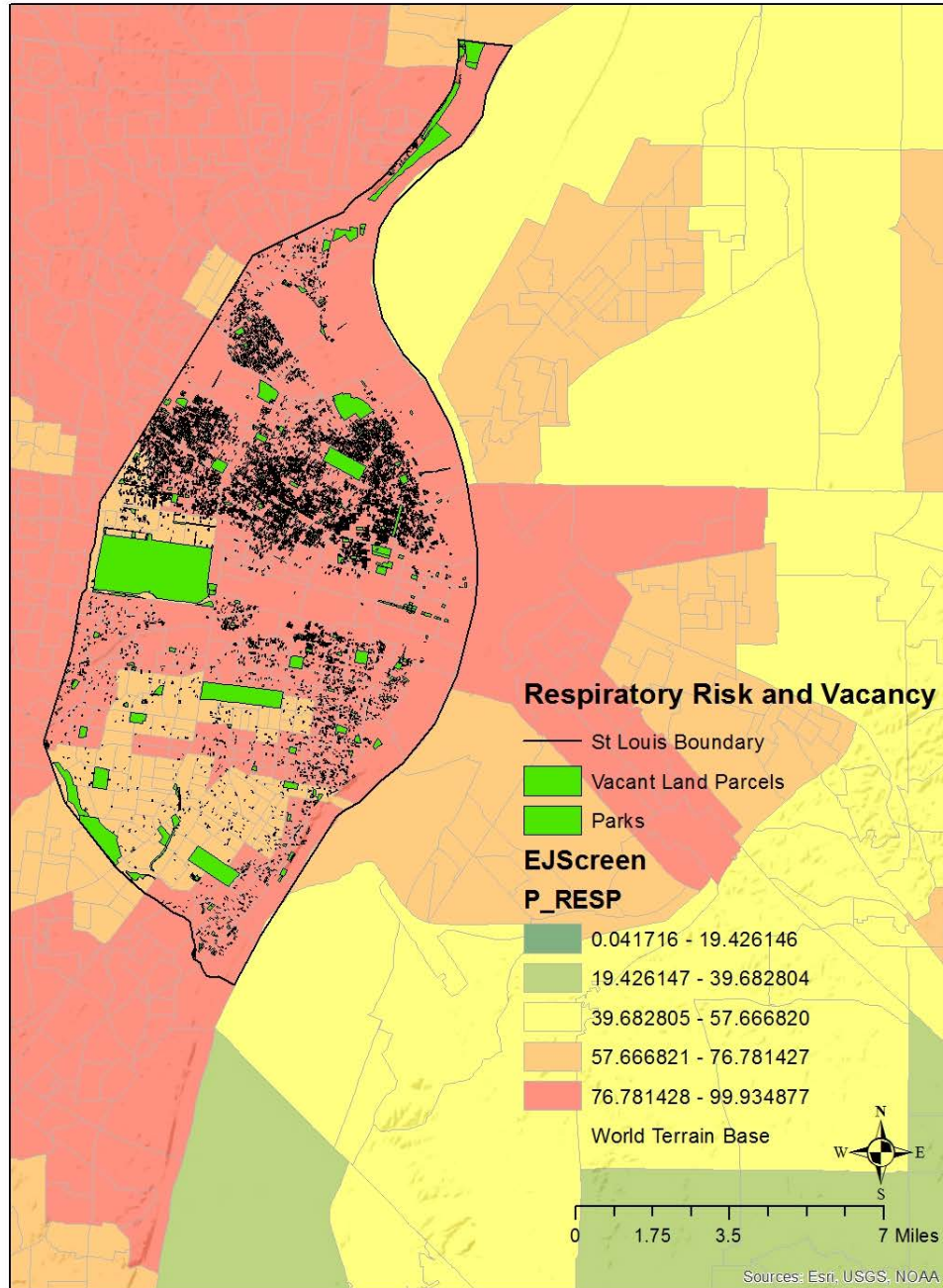




Figure 94: Respiratory Risk and Land Vacancy in St. Louis

#### 6.2.7.7 Proximity to PM 2.5 and Vacancy

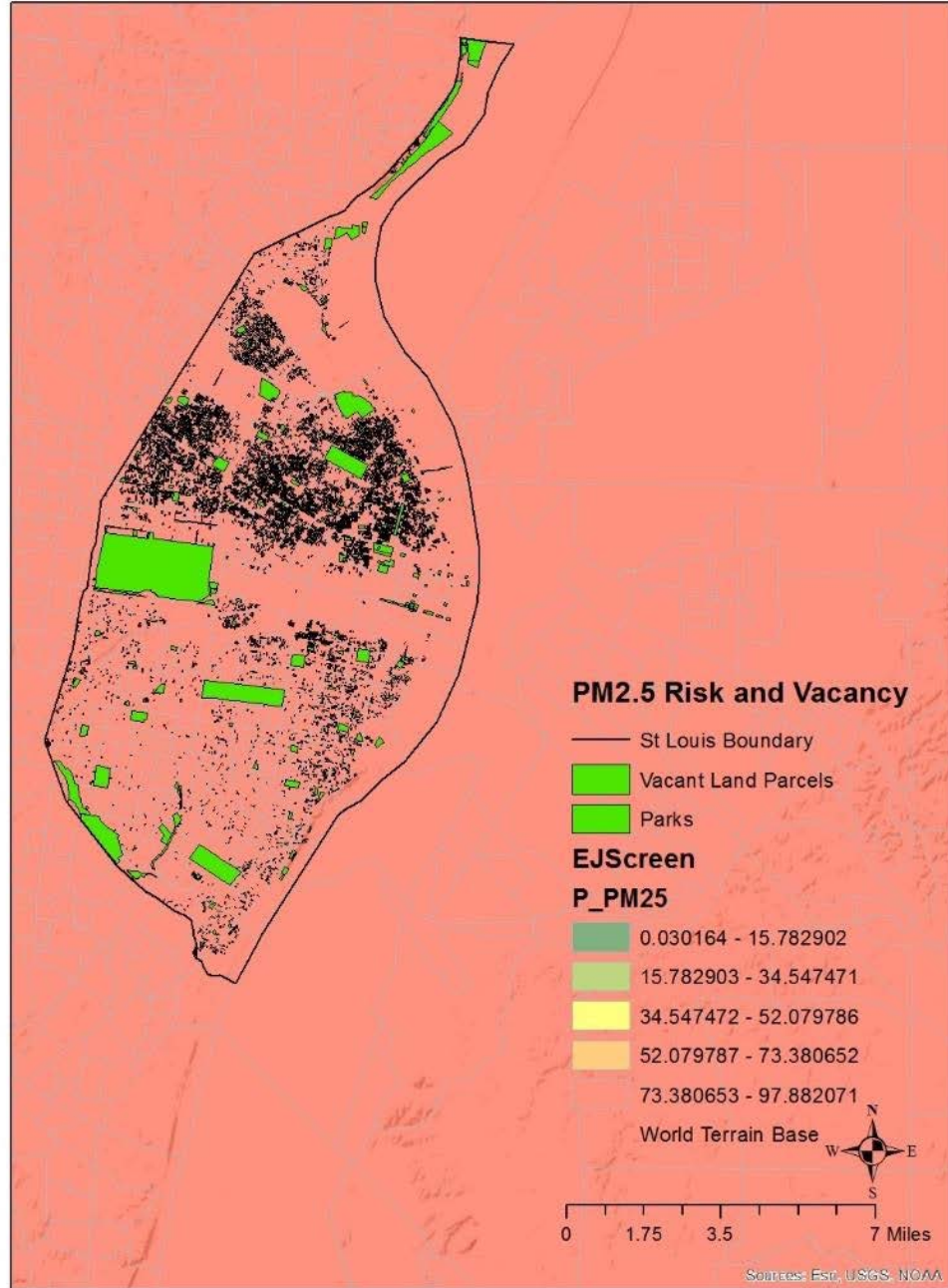


Figure 95: PM2.5 Risk and Land Vacancy in St. Louis

PM 2.5 data for St. Louis was insufficient to differentiate habitat quality in St. Louis (Figure 95).

#### **6.2.7.8 Proximity to Diesel PM and Vacancy**

Seventy-eight percent of publicly owned vacant land parcels are in marginal habitat based on diesel PM pollution (Figure 96). Twenty-two percent are in suboptimum habitat and none are in optimum habitat.

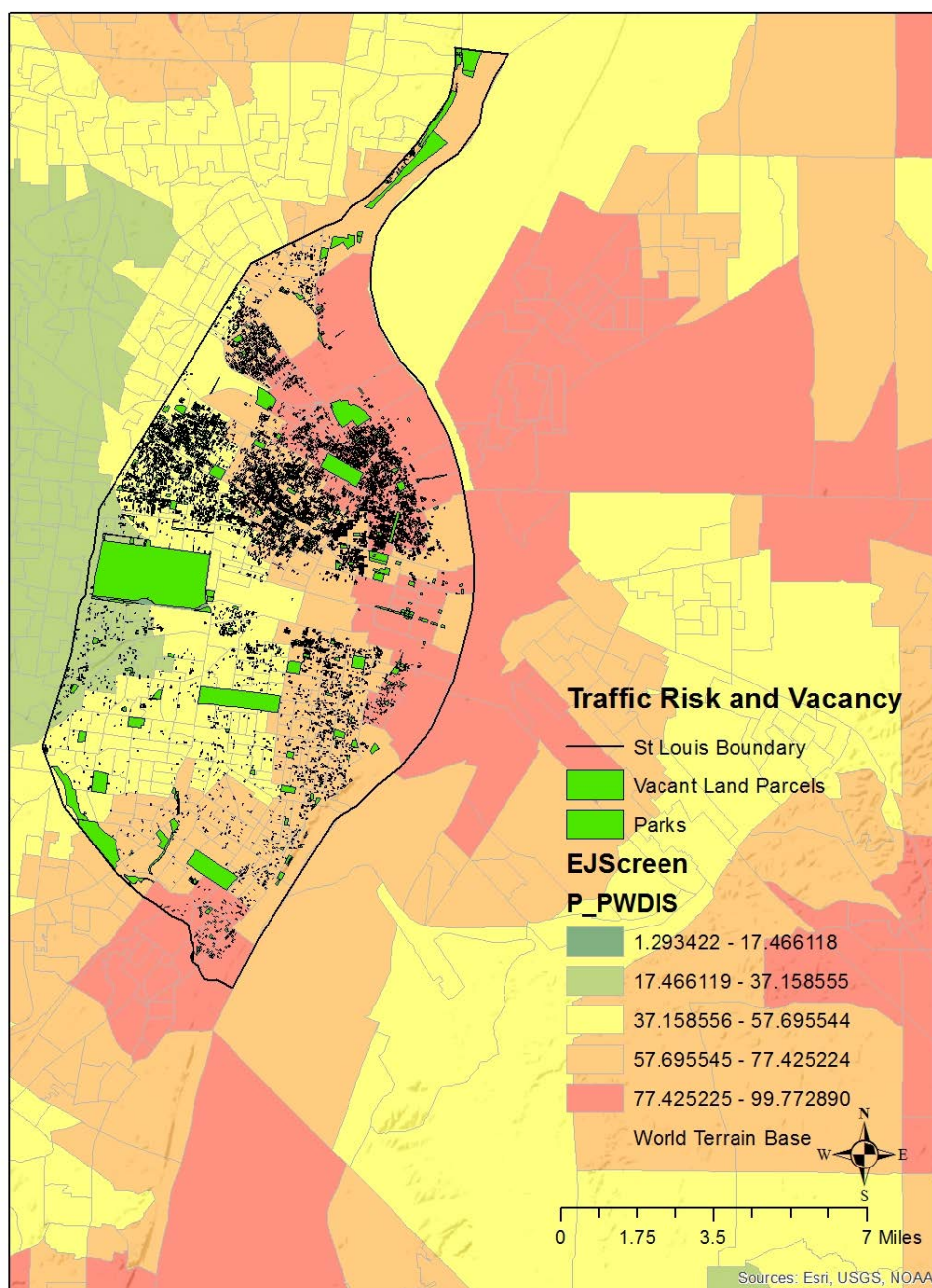


Figure 96: Diesel PM Risk and Land Vacancy in St. Louis

#### 6.2.7.9 Proximity to Ozone and Land Vacancy

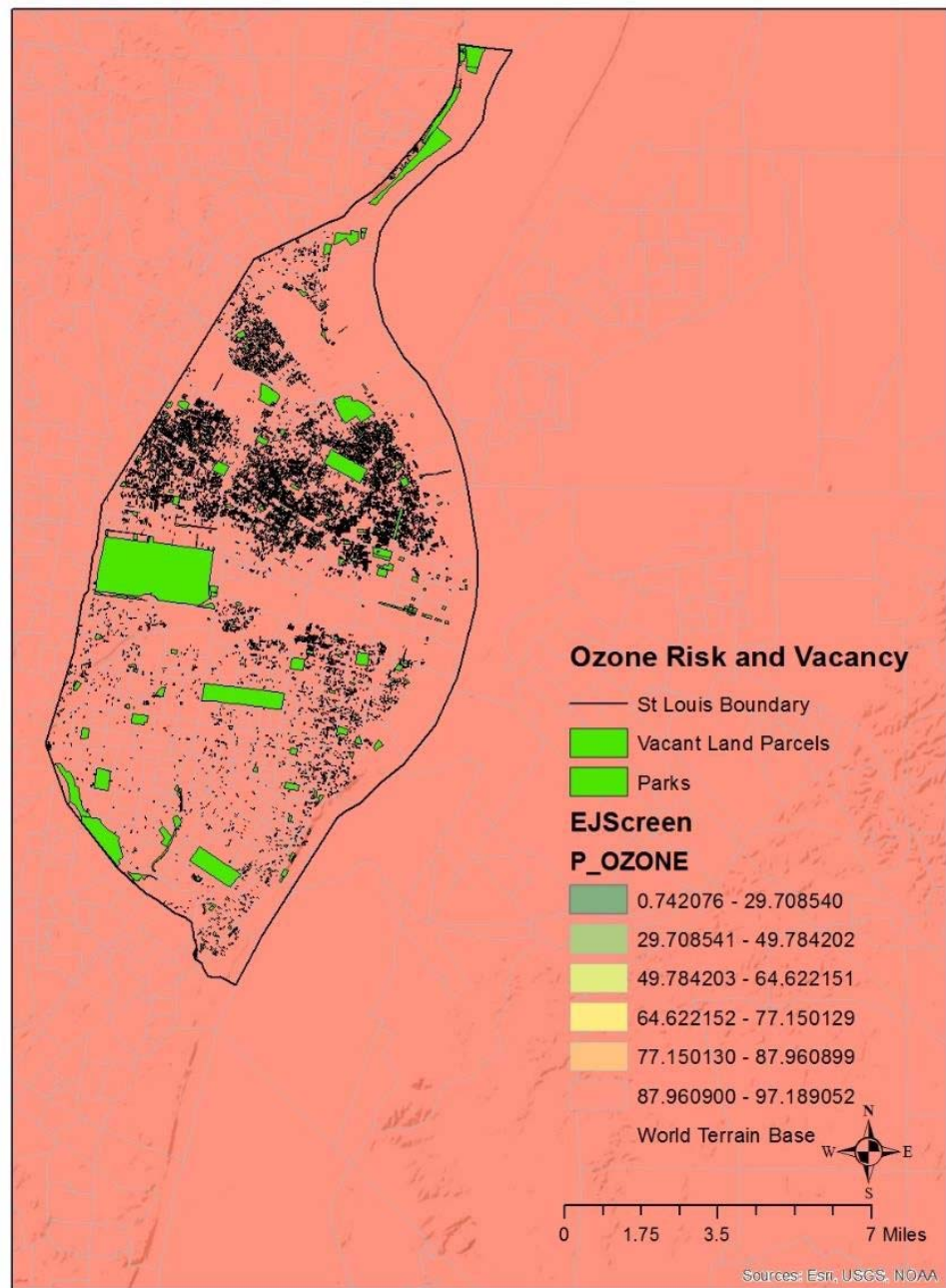


Figure 97: Ozone Risk and Land Vacancy

In addition, major highways can contribute to ozone pollution. Ground level ozone is an irritant that damages lung tissue, aggravates heart and respiratory disease and can contribute to mortality. St. Louis does not meet National Ambient

Air Quality Standards established by the Environmental Protection Agency. Ozone is particularly a problem in St. Louis where higher temperatures cause the ozone to react with vehicle emissions and create smog. As areas of high vacancy are impacted by proximity to traffic it follows that they would also be areas which experience high ozone pollution as well (Figure 97). However, ozone was demonstrated to be a poor indicator of vacancy because data is not parsed on a census tract basis and is uniform for the entire city. While ozone pollution influences habitat quality in New Orleans and St. Louis data was not available in sufficient detail to be useful for this research.



#### 6.2.2.10 Proximity to EPA Brownfield Sites

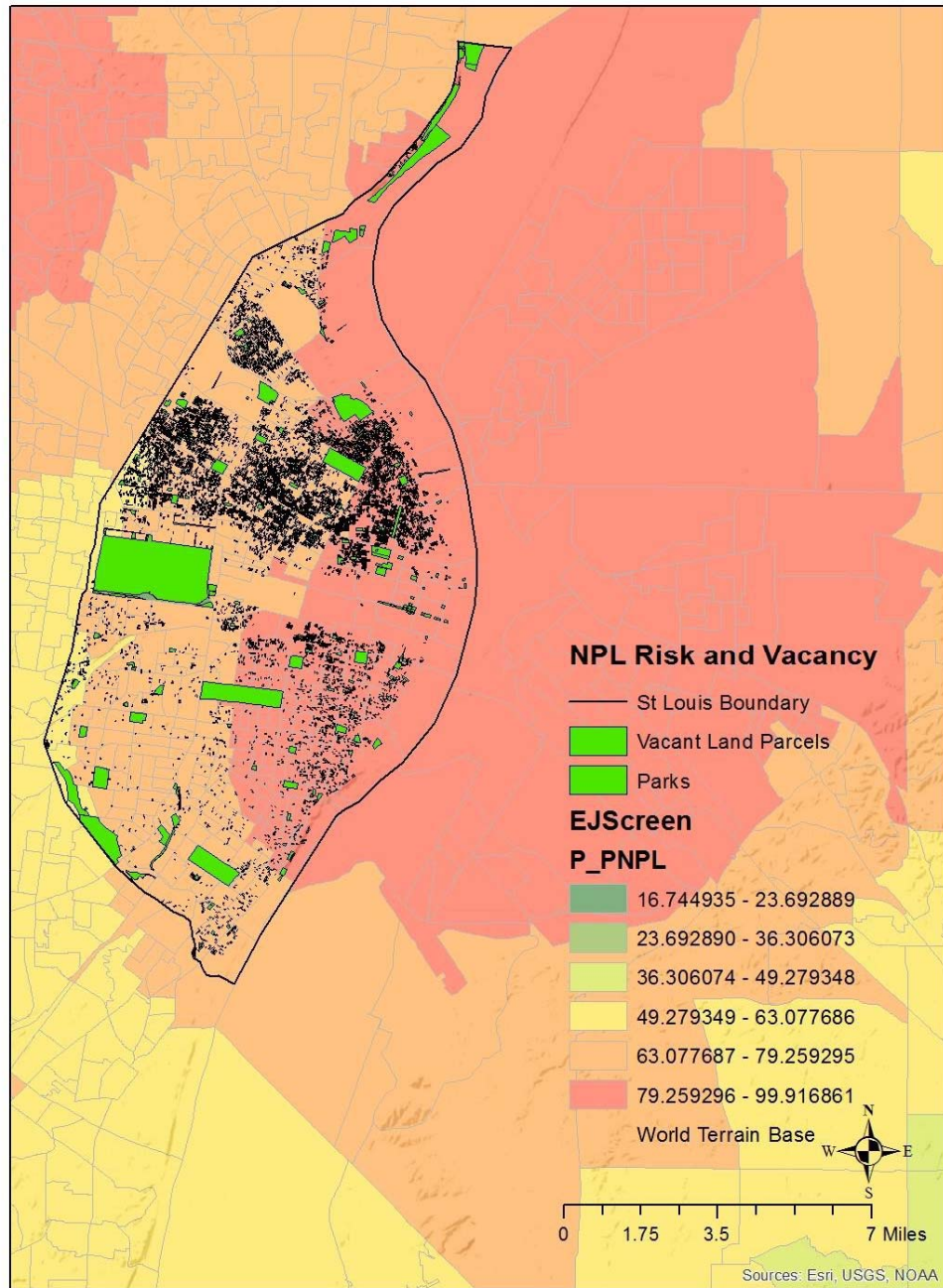


Figure 98: NPL (Superfund Sites) Risk and Vacancy in St. Louis

Eighty-two percent of publicly owned vacant land parcels in St. Louis were in marginal habitat and eighteen-percent were in suboptimum habitat (Figure 98). None were in optimum habitat.

#### **6.2.2.11 Proximity to EPA RMP Sites and Vacancy**

Eighty-seven percent of publicly owned vacant land parcels are in marginal habitat based upon proximity to Risk Management Plan (RMP) sites (Figure 98). These are sites with potential for chemical accidents. Thirteen percent of publicly owned vacant land parcels are in optimum habitat based upon these sites and none within suboptimum habitat.

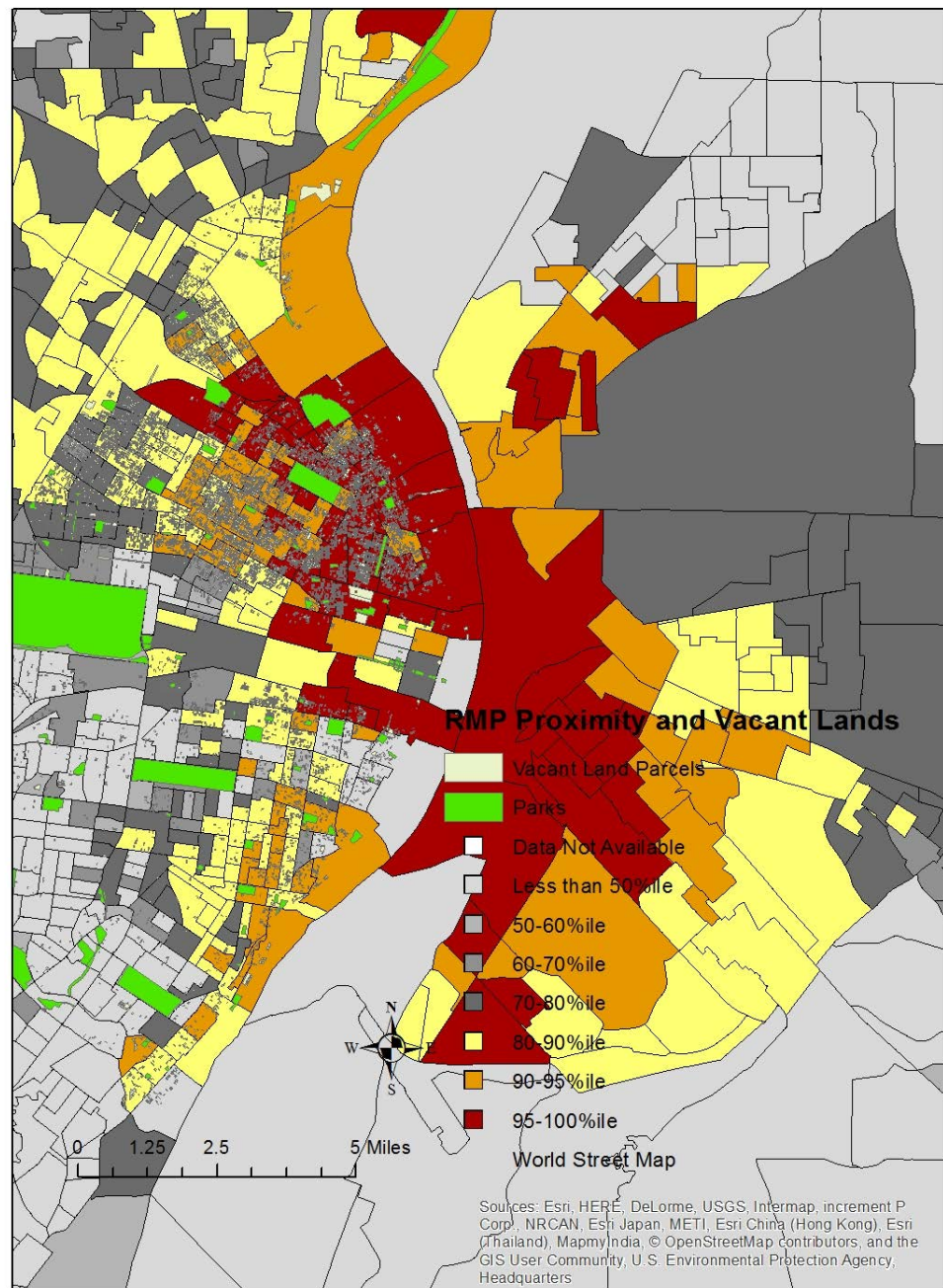


Figure 99: RMP Risk and Vacancy in St. Louis

#### 6.2.2.12 Proximity to Water Discharge and Vacancy



Eighty-seven percent of publicly owned vacant land parcels are in marginal habitat based upon proximity to water discharge sites (Figure 99). Thirteen percent of publicly owned vacant land parcels are in optimum habitat based upon these sites and none within suboptimum habitat.

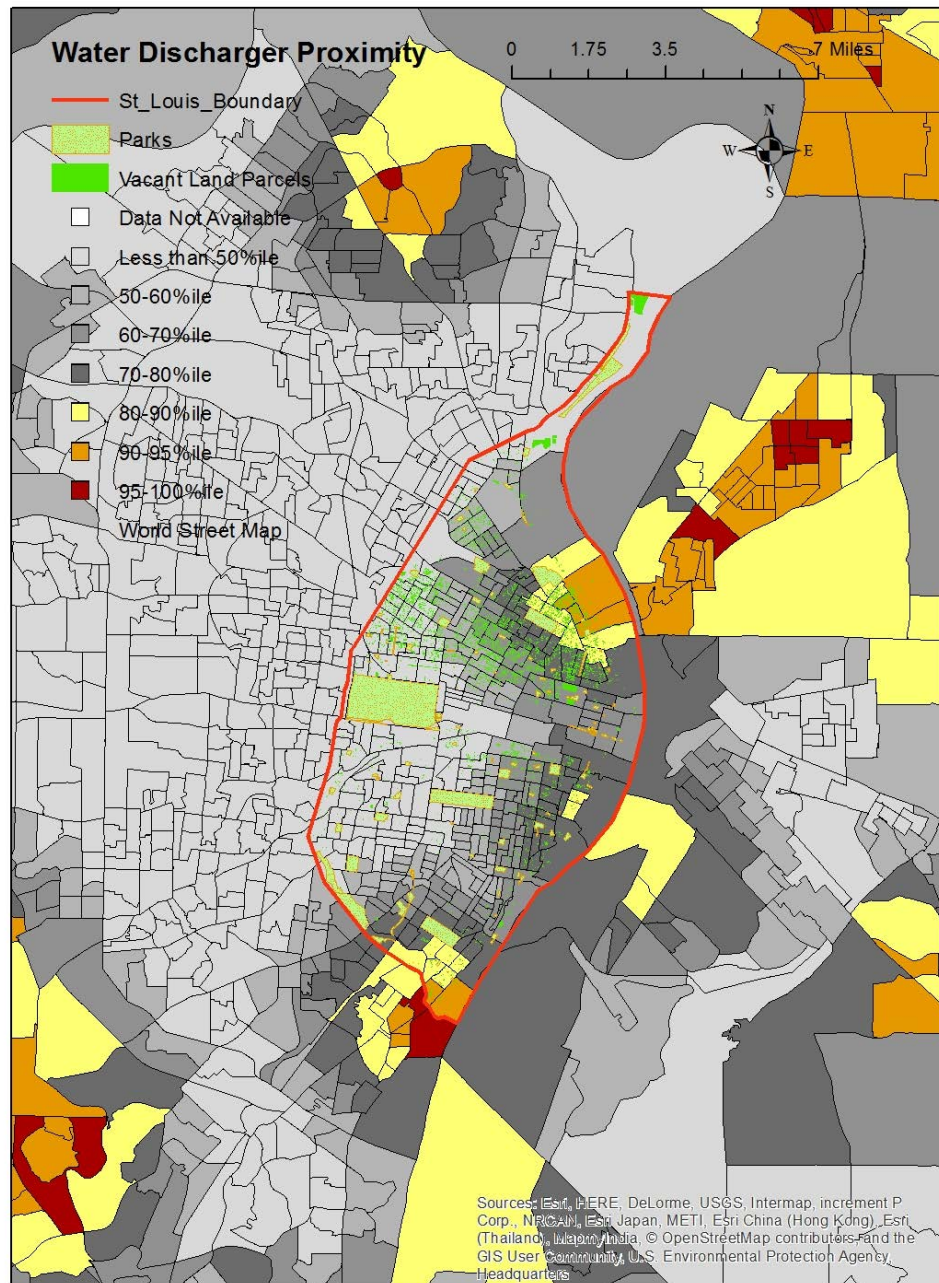


Figure 100: Water Discharge Proximity and Land Vacancy in St. Louis

### 6.2.2.13 Proximity to Treatment and Storage Disposal Facilities and Vacancy

Eighty-seven percent of publicly owned vacant land parcels are in marginal habitat based upon proximity to regulated storage and disposal facilities (TSDF sites) Thirteen percent of publicly owned vacant land parcels are in optimum habitat based upon these sites and none within suboptimum habitat.

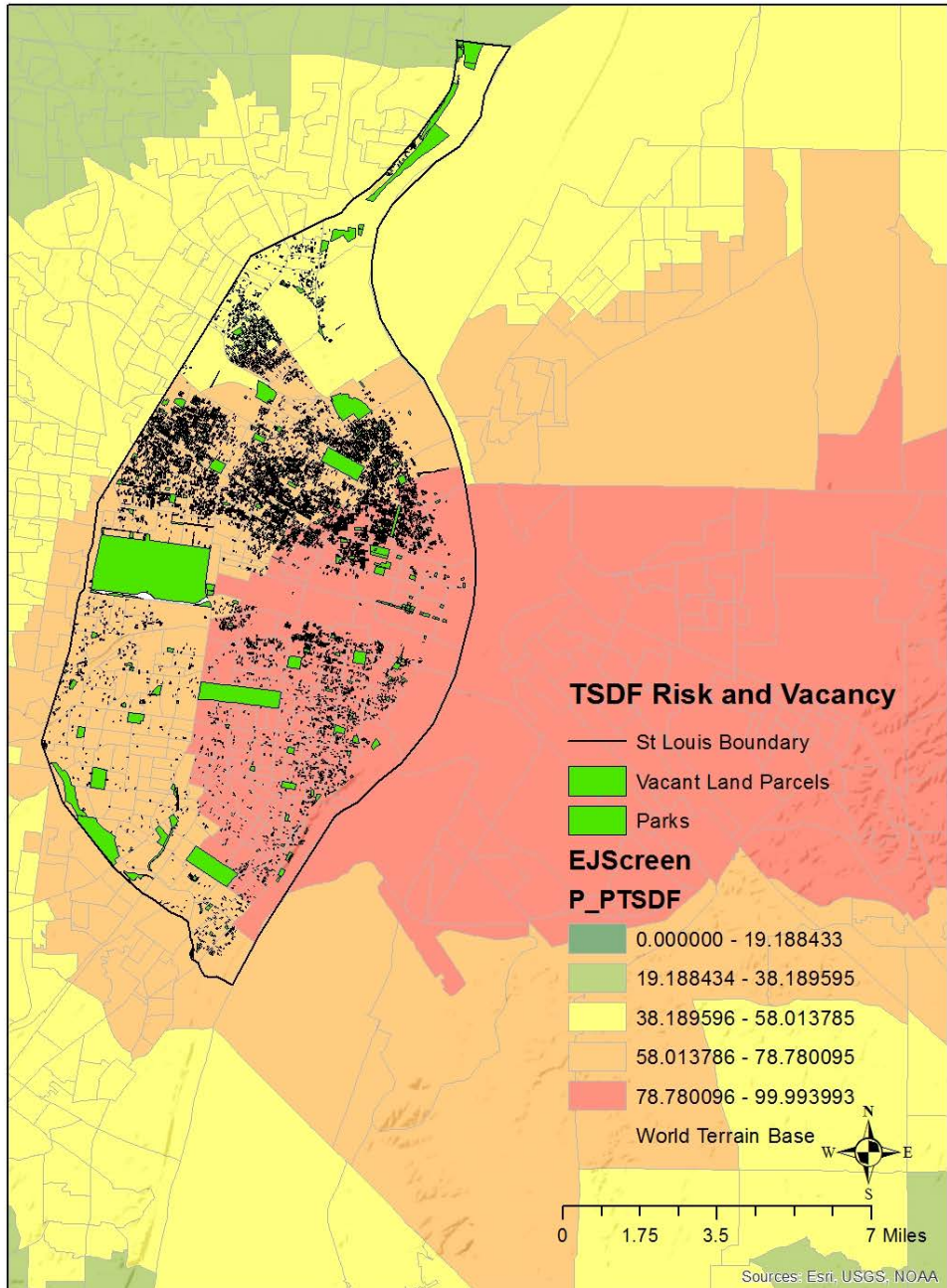


Figure 101: Treatment and Storage Disposal Facilities and Land Vacancy in St. Louis

#### 6.2.2.14 Proximity to Lead and Vacancy

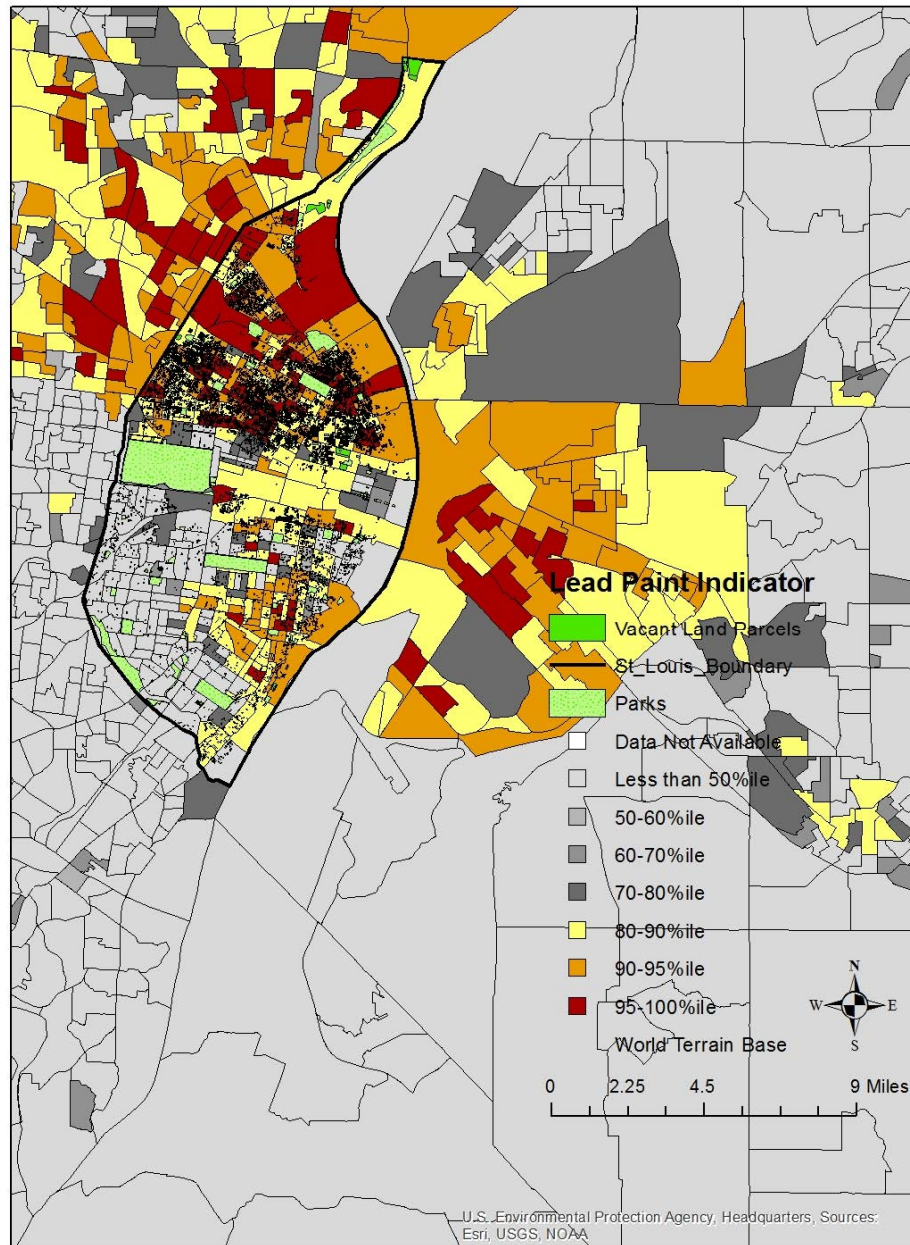


Figure 102: Lead Paint Risk and Vacancy in St. Louis



Eighty-five percent of publicly owned vacant lands in St. Louis are in marginal habitat based upon lead risk. Twelve percent are in suboptimum habitat and nine percent are in optimum habitat (Figure 102).

### **6.2.3 Natech Risk**

The importance of the Mississippi riverfront to industrial development in St. Louis is illustrated by this map of floodplain contamination overlaid with vacant land parcels (Figure 101). Buried storage tanks, contaminated lands under long term stewardship, sites on the toxic release inventory, and areas under active management, and hazardous waste boundaries sites are concentrated along the riverfront and the Mill Creek railroad corridor, placing many St. Louis residents within harms' way.

The potential for Natech risk in St. Louis is found along the Mississippi River and drainages in the region, where industrial and chemical facilities are located where flooding may occur. These sites are concentrated along the Mississippi River north of the Near North Side and along the Mississippi River in south St. Louis, both locations with high concentrations of vacant lands. Because this data was only available as point data rather than raster data the relationship with publicly owned land vacancy was difficult to evaluate (Figure 101).

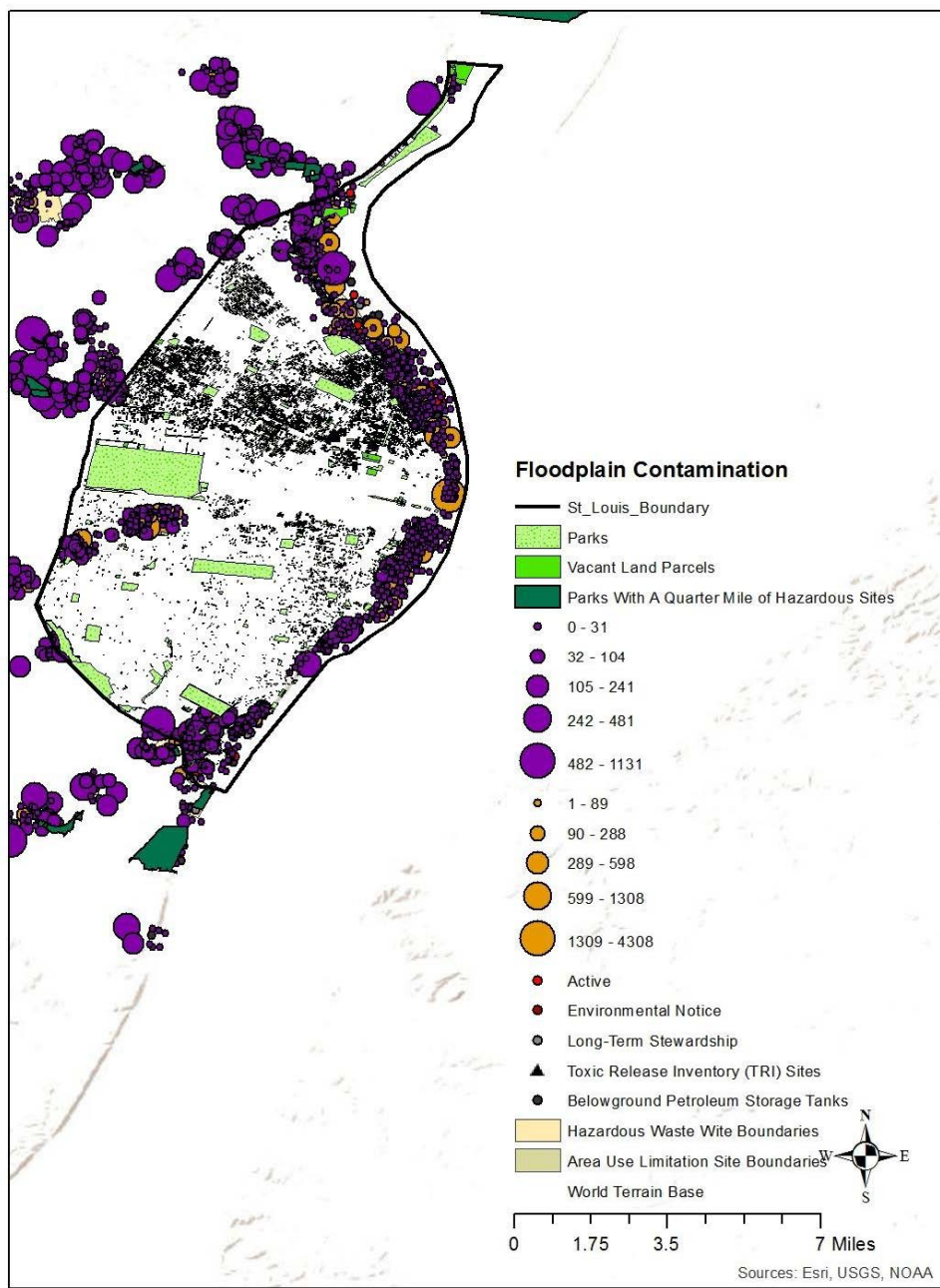


Figure 101: Floodplain Contamination and Land Vacancy in St. Louis

### **6.2.9 Real Estate Values and Land Vacancy**

The combination of proximity to opportunities and proximity to geophysical, social, technological, and natech risks influence real estate prices in and St. Louis.

Only two percent of publicly owned vacant land parcels are found in census tracts within the upper third of median home values. Twenty-five percent are found within census tracts in the middle third of median home values. Seventy-three percent of publicly owned vacant land parcels are found in census tracts in the lower third of median home values. This suggests that vacancy is highly related to low

market demand. Land is vacant in part because no one wants it.

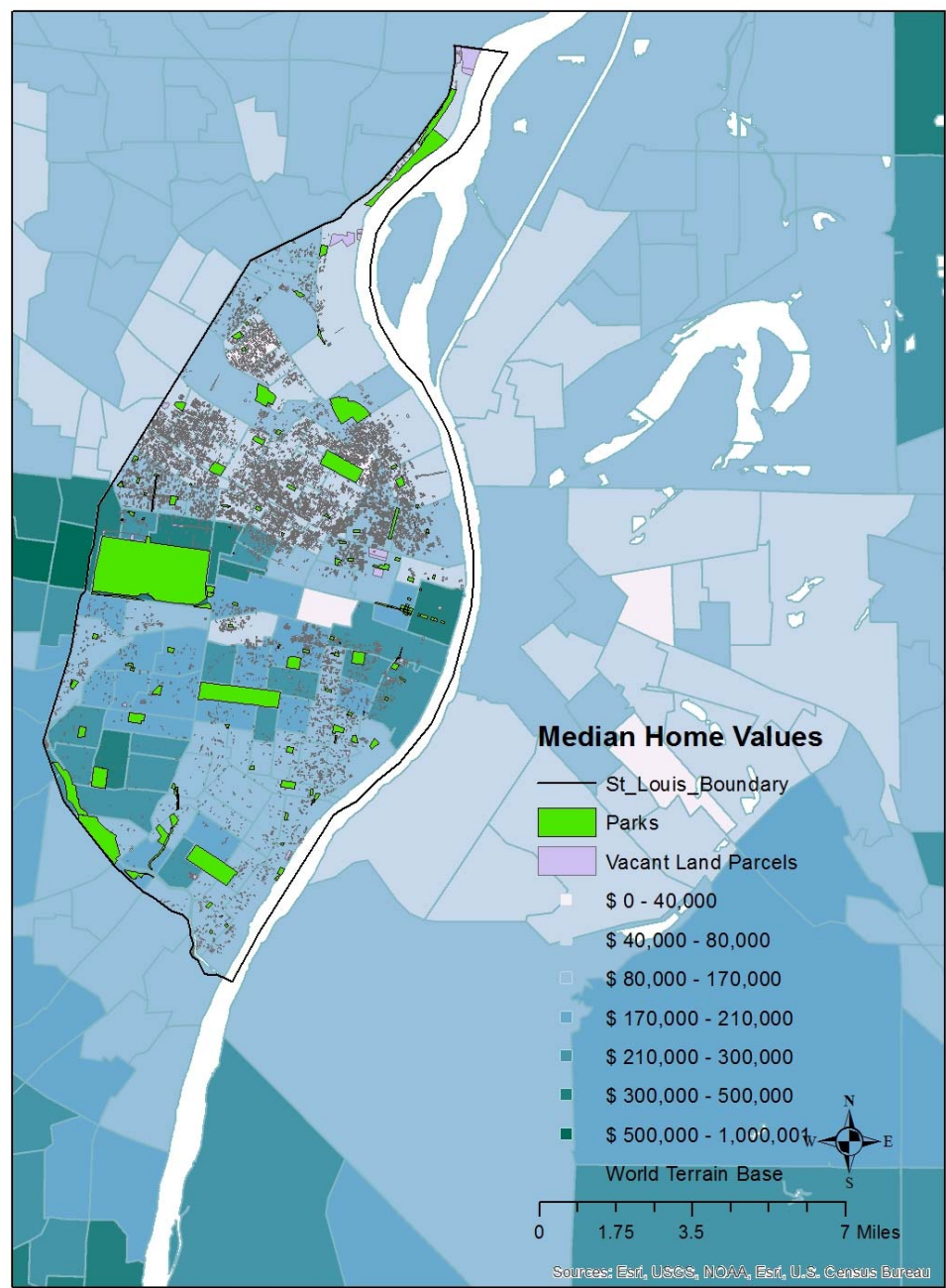


Figure : Median Home Values and Land Vacancy in St. Louis

6.2.10 Case Studies Comparison

A comparison of the two case studies reveals interesting conclusions. New Orleans is a city with an advantageous commerce-related situation near the mouth of the Mississippi River but with an extremely poor environmental situation in terms of its susceptibility to flooding and subsidence. The relative lack of Native American settlements in the area prior to European settlement of the region suggests that sites further north and less subject to flooding were preferred for permanent settlements. Nonetheless, until the 1920s (and the invention of an efficient pumping system to drain low-lying areas), New Orleans was generally built along the natural levees of the Mississippi River, Bayou St. John, and Bayou Metairie. Though the city periodically flooded, and levees were constructed, the urban form of New Orleans remained largely in concert with the natural environment until the close of the Civil War in 1865.

With the Emancipation Proclamation, newly freed residents sought housing and job opportunities in the city. Increasingly they and immigrants that arrived into the community found places for residential habitation on the marginal lands along the wharves of the Mississippi River and in the back swamp between the Vieux Carré and Lake Pontchartrain. Gradually more and more of the city was built in conflict with the natural environment. There is significant relationship between these environmental hazards and the presence of vacant land parcels.

With the advent of sophisticated pumping technology in the 1920s, this pattern accelerated as the city rapidly expanded onto swamp and marsh land that was historically considered undesirable due to its potential for flooding and due to the presence of disease-carrying mosquitos. Though new technology and infrastructure in the forms of pumps and canals partially overcame the impediment created by these geophysical constraints, most fatalities during Hurricane Katrina were residents of these formerly environmentally constrained lands.

With the post-Civil War 'Jim Crow' laws, reinforced by *Plessy v. Ferguson* Supreme Court case in 1893, the city increasingly became more racially divided. With proposals for racial zoning in 1916, racial covenants, and red-lining,



management decisions through the 20<sup>th</sup> century created a divided city and designated major areas of the city as undesirable for white residents. There is significant relationship between the spatial manifestations of these management decisions and vacant land parcels.

The construction of the Industrial Canal early in the twentieth century and the Mississippi River-Gulf Outlet Canal (MRGO) in the mid- century created large areas of industrial lands accessible to maritime transit. The Mississippi River – Gulf Outlet Canal is a 76 mi (122 km) channel completed in 1965 by the United States Army Corps of Engineers provided a shorter route between the Gulf of Mexico and New Orleans' inner harbor Industrial Canal via the Intracoastal Waterway. Residential neighborhoods within close proximity of these risks have experienced major vacancies. With the construction of Interstate 10 through the city in 1960s and the destruction of many African American businesses of Claiborne Avenue, the city experienced another major disturbance.

In contrast to New Orleans, the site of St. Louis is an excellent location for a city. Though the site is subject to periodic earthquakes, moderate earthquakes are only experienced every few decades. Scientists predict a major earthquake every 2000 to 4000 years. Tornadoes have ripped through the central business district of the city four times since the city's founding, but with less damage, less loss of life, and less frequency than the hurricanes that strike New Orleans.

In addition, the city is set on a bluff overlooking the Mississippi River, and although the River Des Peres, Mill Creek, Harlem Creek, and Maline Creek have periodically flooded, St. Louis is not subject to the same flood hazards as New Orleans. Though industrial lands along the Mississippi River are subject to flooding, the Central Business District and the majority of residential areas are out of harm's way.

Unlike New Orleans, major portions of St. Louis are not subject to geological or soils constraints. New Orleans residents must contend with

subsidence issues that influence construction, but St. Louis is built upon loess deposits and karst limestone much more conducive to construction. Land vacancy due to conflicts with geophysical hazards are far less frequent in St. Louis than in New Orleans. As in New Orleans, land vacancy in St. Louis due to proximity to nuisance land uses such as factories and rendering plants are significant.

Much of the publicly owned land vacancy in St. Louis is a byproduct of management decisions. While New Orleans did not enact massive land clearance during the urban renewal programs of the 1960s, St. Louis very aggressively cleared land, and much of this publicly owned land remains vacant in 2016. As in New Orleans, racial zoning, restrictive covenants, redlining, and “separate-but-equal” schools and public facilities, dating from the first half of the twentieth century racially divided the city. The impact of these management decisions, or manmade disturbances were so severe that the level of publicly owned land vacancy in St. Louis is comparable to that of New Orleans.

## **CHAPTER 7 – DISCUSSION AND CONCLUSIONS**

This chapter draws together the findings of the six previous chapters in order to best answer the research sub-questions posited in Chapter One and the main research question which is: How can an understanding of the historical ecology of a city provide a useful guide to publicly owned vacant land policy? This chapter provides a commentary on how the methods worked together and whether the anticipated results were achieved. The chapter concludes with an evaluation of the results, and the policy and planning implications, based on this research's key conclusions, and the directions for future research.

### **7.1 Discussion**

The methods utilized in the two case studies are concerned with establishing a framework for publicly owned vacant land policy in shrinking cities. This section first provides an evaluation of the methodology. Then this section answers the individual sub-questions and finally, it addresses the theoretical considerations, with the intention, then, to develop some general, cross-case conclusions.

This thesis initially set out to determine if an understanding of historical ecology and environmental history could provide a guide to publicly owned vacant land policies for shrinking cities. It quickly became clear that geophysical risks were but one factor to be considered in understanding publicly owned land vacancy.

This research suggests that the primary cause of publicly owned land vacancy in New Orleans and St. Louis is the absence of opportunities, including educational, social and economic, health, and environmental. This is particularly true in St. Louis where eighty-four percent of the publicly owned vacant land parcels are found in marginal habitat and seven percent in suboptimum habitat as defined by proximity to opportunities (a total of ninety-one percent). In New

Orleans, sixty percent of publicly owned vacant land parcels are found in marginal habitat and twenty-four percent in suboptimum habitat based on proximity to opportunities (a total of eighty-four percent). This would suggest that the greatest priority in addressing publicly owned vacant land is the provision of opportunities – notably employment and educational opportunities to those areas of the city with significant land vacancy. Although supported by the data, this conclusion is consistent with an understanding of the history of both cities, the impact of post-Fordism, and the loss of industrial employment over time which has impacted both New Orleans and St. Louis. Both New Orleans and St. Louis, illustrate the concerns of uneven development, as expressed by urban political ecologists. Whether this uneven development is strictly a product of capitalism as some would suggest or common to all economic systems is a topic for further research.

Data from this research suggests that the secondary cause of publicly owned land vacancy is proximity to technological risks. Areas of high publicly owned land vacancy are related to proximity to cancer, respiratory, brownfield, and other risks. In New Orleans sixty-eight percent of publicly owned vacant lands lie within marginal habitat and twenty-eight percent (a total of ninety-six percent) based upon proximity to technological risks. In St. Louis, seventy-four percent of publicly owned vacant lands lie within marginal habitat and fourteen percent lie within suboptimum habitat (a total of eight-eight percent). Management decisions such as racial zoning, racial covenants, and redlining concentrated certain social groups near the industrial areas of the city. Employment opportunities left major areas of New Orleans and St. Louis, leaving residents who lived near these industrial areas with the terrible legacy of environmental pollution. This research would suggest that the second priority for reducing publicly owned land vacancy and in improving the well-being and quality of habitat of residents living in areas of high publicly owned land vacancy is through cleaning up pollution and addressing issues of environmental justice. Though as urban political ecologists have suggested, geophysical conditions have become less important over time as *Homo sapiens* have utilized technology to gain control over nature, at the same time technology has contributed to a decline of habitat quality in some situations.

This research suggests that social risks are the third cause of publicly owned land vacancy. Publicly owned land vacancy is highly related to areas of African-American residency. Fifty-three percent of publicly owned vacant lands in New Orleans (sixty-nine percent total) are in areas of predominantly African-American population. In St. Louis seventy-seven percent of publicly owned vacant land parcels are in areas of predominantly African-American population. Poverty is highly related to publicly owned land vacancy. In New Orleans, thirteen-percent of publicly owned land vacancy is found in marginal habitat based upon poverty, and sixty-six percent in suboptimum habitat (seventy-nine). In St. Louis, sixty-six percent of publicly owned land vacancy is found in marginal habitat based on poverty, and twenty-nine percent in suboptimum habitat (a total of ninety-five percent). These social risks are in great measure a legacy of racially based management decisions made over centuries. Poverty is, of course, related to opportunities for employment which in turn generally requires education and skill development. Decades of school desegregation in large denied these opportunities to African-Americans in New Orleans and St. Louis. Racial zoning, racial covenants, redlining, demolition through urban renewal, and concentration of low income and largely minority populations into public housing projects led to the ghettoization of major populations of New Orleans and St. Louis. It is in these areas where major areas of publicly owned land vacancy are found. The provision of opportunities and the elimination of industrial risks and pollution are essential to addressing the issue of publicly owned land vacancy, but attention must also be given to addressing racism and the impacts of the racist policies put in place to support this ideology.

Finally, although this thesis initially set out to understand whether historical ecology and an understanding of environmental history could aid in the development of publicly owned vacant land policies in shrinking cities, this research suggests that geophysical risks have a weaker relationship to publicly owned vacant lands that does proximity to opportunities and social and technological risks. New Orleans, which is dramatically impacted by flooding and a hurricane disturbance regime, is indeed subject to significant geophysical risks. Forty-nine percent of publicly owned vacant land parcels in New Orleans are in

marginal habitat and thirty-one percent are in suboptimum habitat based on geophysical risks (a total of eighty percent). Conversely in St. Louis which is an exceptional site for a city, only three percent of publicly owned vacant lands are in marginal habitats and none are in suboptimum habitat based on geophysical risks. Ninety-seven percent of publicly owned vacant land parcels in St. Louis are in optimum habitat from a geophysical perspective, suggesting that proximity to opportunities, and distance from technological and social risks are far more important than geophysical conditions in determining the location of publicly owned vacant lands. Smith has argued that the present reality of New York City has long since outgrown any naturalistic explanation based on bedrock or physical accessibility. Further research may suggest that New York, like St. Louis, possesses an exceptional site for a city and thus has indeed outgrown any naturalistic explanation for its prosperity. New Orleans, however, has not, and the same may be true for other cities.

What does this conclusion mean for landscape architects, architects, planners, urban designers, and elected and appointed officials tasked with addressing issues of publicly owned vacant lands. First, it suggests that the problem is more than one of physical planning. Aligning the physical form of the city with the underlying geophysical condition and addressing issues of climate change and environmental resiliency are certainly important, but the challenge of publicly owned vacant lands can not be solved without significant attention to the provision of opportunities for residents in areas of high vacancy, and in the reduction of technological and social risks.

This thesis suggests an approach to publicly owned vacant land policy that is similar to a medical triage. A triage is the sorting of battle or disaster victims according to a system of priorities designed to maximize the number of survivors. By this logic, designers and other individuals would not focus their attention of publicly owned vacant land parcels within optimum habitat. Although market conditions are weak, vacant land parcels in these areas are likely to redevelopment in response to market conditions. Publicly owned vacant land parcels in marginal habitat are going to require considerable government intervention and investment in order to encourage redevelopment. These parcels may best be converted to open

space land uses. Publicly owned parcels with suboptimum habitat, therefore, have the best opportunity for enhancement of opportunities and the minimization of risks, and in turn, redevelopment and should garner the attention of landscape architects, architects, urban designers, and elected and appointed government officials.

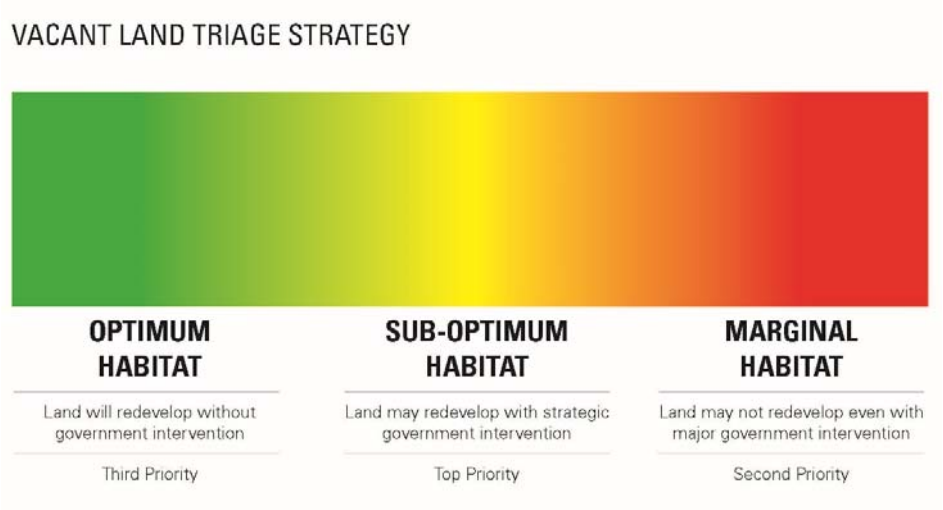


Figure 102: Vacant Land Triage Strategy

Lyle (1985) has suggested that processes of design can be evaluated through a variety of factors including the following:

1. Capacity for complexity or the ability to use a great deal of information from a variety of sources on many different subjects from diverse discipline. Data utilized in this dissertation obtained from a variety of sources from diverse disciplines are synthesized in this research effort. Fifty-one factors are considered in assessing habitat quality. These factors or indicators are causes of publicly owned land vacancy.
2. A capacity for prediction or the ability to estimate the potential effects of a proposed intervention on the existing environment. The deterministic predictions possible in the physical sciences are not possible in biology. Generalizations in biology are almost invariably of a probabilistic nature (Mary,

1982). Therefore, this thesis provided a capacity for descriptive model of the location of vacant lands by mapping and analyzing where development has occurred in conflict with nature, in proximity to risks such as industrial lands or major infrastructure or was disturbed by management interventions and demonstrating the relationship of publicly owned vacant lands and these types of disturbances. By comparing land vacancy to Pre-Columbian and Present Day Habitat Quality Models, and to each individual opportunity and risk, the major indicators of publicly owned land vacancy were identified. This thesis does not attempt to describe causal relationships.

3.       Defensibility or a clear and logically correct framework to support claims. By defining a framework that can be replicated in other cities and assembling sources for supporting data, a clear framework for use by future researchers was provided. Furthermore, this thesis describes the limitation of the study and offers suggestions to guide future research.

4.       Communicability or the ability of a proposal to be understood by the public. Through the creation of maps and time lapse animations, the content of this research can be communicated to the public.

#### **7.1.1 Evaluation of the Methodology**

This thesis showed the strengths and weaknesses of the selected methodology. The use of historical maps and accounts were successfully utilized to develop a graphic depiction of the environmental history of the sites of New Orleans and St. Louis.

An understanding of the environmental histories of New Orleans and St. Louis provided valuable insights into the adaptations of *Homo sapiens* in those locations to their environment. Time series data for the entire history of New Orleans and St. Louis was not available, but a time lapse analysis of both cities for a substantial portion of their history illustrated the persistence of optimum, suboptimum, and marginal habitat for *Homo sapiens*.



By addressing a view of *Homo sapiens* as part of nature rather than separate from nature, this thesis suggested a framework for habitat quality and in turn land vacancy that is not limited to biotic factors but also abiotic factors, many of which were created through the actions of *Homo sapiens* including the development of infrastructure, *Homo sapiens*-made pollution, and the management and social planning actions of *Homo sapiens* for habitat adaptation.

Although not developed specifically as a Habitat Quality model for *Homo sapiens*, the Opportunity Mapping of the Kirwan Institute and the Social Vulnerability Index of the Center for Disease Control provide examples of how areas of opportunity and risk can be mapped within the city and provided the ability to corroborate conclusions. The consistent definition of data categories and collection from city to city, however, created limits for direct comparison of results. The creation of a Habitat Quality model for *Homo sapiens* demonstrated the complexity and challenges of such an effort. What opportunities and risks are appropriate in such a model? What is the relative weight of each factor to the whole? How does the distance effect of each opportunity and risk influence the results of the model? These are important questions for consideration by future research.

The identification of optimum, suboptimum, and marginal habitat by simple division of the data for each of the fifty-one factors into thirds may be too simplistic. Further calibration of each of the factors in the framework is needed. Even marginal habitat supports some population and contributes to population persistence. The *Homo sapiens* living in this marginal habitat have been able to reproduce for generations – the biological definition of fitness. It may be argued that “everyone must live somewhere”, and that occupation of marginal habitat is simply a reality of urban existence. While, this may be true, an understanding of the factors that contribute to habitat quality and in turn to occupancy is still valuable to an understanding how to improve the quality of that habitat and the quality of life of its inhabitants. It is also important to remember that enumeration districts and census tracts are physical boundaries which may or may not relate to the shape of habitat patches.

Further work is needed to establish a systematic hierarchy of the relevant factors. Not all of the factors are needed to predict publicly owned land vacancy. A logical loop emerges because low quality *Homo sapiens* habitat is based on factors that are responsible for land vacancies and thus this criterion logically predicts land vacancies.

## **7.2 The Research Questions**

This thesis provided responses to the principle research questions, as well as, the four sub-questions which follow.

### **7.2.1 Question One: Resiliency, Sustainability and Vacant Lands**

In addressing Lyle's four points of evaluation, this thesis answers one principle research question: how can an understanding of the environmental history of a city provide a useful guide to publicly owned vacant land policy? This question is nested within a larger issue: how has a failure to build in concert with nature impacted the resiliency and sustainability of shrinking cities?

#### **7.2.1.1 How Was the Question Investigated?**

In considering how a failure to build in concert with nature impacted the resiliency and sustainability of shrinking cities, a time series analysis was conducted and a Powerpoint time lapse series was generated to show change in the city over time as measured by several factors including income, employment, poverty, and race. These time lapse series indicated that many patches of habitat within both cities changed over time. Others have remained dramatically consistent, particularly from approximately the 1960s onward. For example, Broadmoor and the Lower Ninth Ward in New Orleans have been poor quality habitat for a century or more, while Lakeshore and the Garden District have been high quality habitat for a similar period of time. Millionaire's Row on the edge of Forest Park in St. Louis has provided high quality habitat for over a century while the Near Northside has been poor quality habitat for an equal period or longer. This suggests the persistence of

optimum habitat, as well as, habitat patches of suboptimum and marginal habitat over time.

While geophysical factors contribute to publicly owned land vacancy in both cities, they are less of a factor than proximity to opportunities or to technological or social risks. Had data been available to also study East St. Louis, built in the floodplain of the Mississippi River, a different conclusion may have been reached.

#### **7.2.1.2 What Were the Findings from the Methodology?**

How resilient have these patches been to major disturbances like Katrina? In New Orleans, the Broadmoor neighborhood, or “The Bowl,” has flooded numerous times dating back to the 1800s, as has the lower Ninth Ward. These areas have remained persistent patches of poverty and vacancy for over 100 years.

The Near North Side of St. Louis has been home to the city’s lower income and racial minorities for at least 100 years. This area contains few geophysical constraints such as wetlands, flooding, or liquefaction. It does, however, contain a host of *Homo sapiens*-made risks including noise, major transportation corridors, and industrial land uses. It also is disproportionately lacking in the opportunities key to high quality habitat. In addition, socially dominant *Homo sapiens*, the city’s leadership deliberately created conditions to isolate minority populations on the north side of the city through the use of racial covenants, racial zoning, and urban renewal programs. In short, the Near North Side of St. Louis is suboptimum habitat as a result of social planning and management decisions and contains the highest concentration of publicly owned vacant lands in the city.

#### **7.2.1.3 How Were the Findings Corroborated?**

The findings of this thesis corroborate the findings of other researchers such as Graves (2012) in New Orleans and Gordon (2009) in St. Louis. Graves

particularly studied the natech risks over time that result from the combination of flooding and industrial land uses along the Industrial Canal and their impacts on the lower Ninth Ward. This research suggests that the Lower Ninth Ward is a patch of persistent poor habitat quality in the city, particularly susceptible to geophysical, technological, and social risk and distant from opportunities. Despite considerable attention and investment since Hurricane Katrina it is likely to remain poor habitat, and if an acceptable alternative can be found for area residents this site is best converted to an open space use. This could be accomplished with minimal disruption to residents if publicly owned vacant lands were gradually converted to an open space use rather than involuntarily relocating residents.

Gordon's work examined the impact of racial zoning, racial covenants, redlining, and urban renewal on St. Louis. These findings also support the findings of the Kirwan Institute's opportunity mapping efforts for New Orleans and St. Louis, as well as, the Social Vulnerability Index of the Center for Disease Control.

#### **7.2.1.4 What is the Comparison Between the Two Cases?**

The *Homo sapiens* habitat of cities is a contested landscape and a city's environmental history is a record of that contestation. There are areas in both cities of suboptimum habitat that are not impacted by geophysical constraints like flooding or subsidence, or liquefaction. These areas persist as suboptimum habitat because of the impacts of racial covenants, redlining, and other social planning and management decisions, as well as, the impacts of major infrastructure projects or adjacencies to industrial land uses.

#### **7.2.2 Question Two: A Guide to Vacant Land Policy**

From the overarching issue of resiliency, sustainability, and land vacancy, the key question of this thesis emerges: how can an understanding of the environmental history of a city provide a useful guide to publicly owned vacant land policy?

#### 7.2.2.1 How Was the Question Investigated?

The creation of a Habitat Quality Model for *Homo sapiens* offers a framework for understanding the resources important to creating opportunity for *Homo sapiens* development as well as the environmental stressors which create risk for *Homo sapiens* well-being. Such models are applicable to publicly owned vacant land policy in shrinking cities and may offer promise to policy makers who shape growing cities as well. Optimum habitat contributes to occupancy and suboptimum and marginal habitat quality to vacancy. The past development of lands in conflict with geophysical risks such as flooding created patches of persistently suboptimum or marginal habitat, reducing the resiliency and sustainability of New Orleans and St. Louis.

This thesis mapped opportunities and risks and then overlaid a map layer of publicly owned vacant land parcels. The number of publicly owned vacant lots in conflict with these risks was counted. Then the percentage of the total number of publicly owned vacant lots in conflict with each risk was then calculated.

The Present Habitat Quality Map offered the basis for creation of a Vacant Land Management Strategy Map. Publicly owned vacant land parcels are classified as developable (optimum habitat), development reserve (suboptimum habitat), or an uninhabited land use (marginal habitat). Uninhabited lands could still be utilized for parks, open space, agriculture, forestry, or land uses such as industrial or warehousing that do not involve habitation. If marginal habitat contributes to vacancy, then two choices are available to decision makers. Either additional or better quality opportunities can be provided and risks reduced to improve the quality of the habitat or the marginal habitat can be converted to an uninhabited use such as parks, urban agriculture, urban forestry, or wildlife habitat. Where risks such as flooding, subsidence, or steep slopes create persistently marginal habitat, the latter path may be preferable. The third choice would include the enhancement of habitat, as well as, the conversion of marginal habitat to uninhabited land uses.

Simply addressing geophysical risks is not sufficient to transform a city or to reduce the quantity of publicly owned vacant lands. Habitat must be improved in a variety of ways including the provision of resources such as increased employment and educational opportunities, improved information infrastructure, a variety of appropriately scaled transportation improvements, the elimination of food deserts, the provision of locally serving retail and services, the enhancement and preservation of cultural resources, access to investment capital, the provision of parks and open space, and the reduction of crime. Risks may be reduced in a variety of ways as well including drainage improvements, enhancement of the urban forest, cleanup of brownfields and other contaminated areas, the reduction of soil and air pollution, the careful placement, rightsizing, and buffering of urban infrastructure including highways, railroads, industrial areas, pipelines, powerlines, landfills, and incinerators.

Where habitat is suboptimum, vacant lands may be committed to an interim uninhabited use and held as a development reserve until market demands justify its redevelopment. The current introduction of urban agriculture and urban forestry in shrinking cities like Detroit may not be “permanent” solutions to the emptying out of these cities but interim strategies for holding vacant lands until a market-based solution materializes. When the economies of these communities recover, these lands may be converted once again to urban development for a second time in the city’s history.

Where habitat is optimum it may still be strengthened by enhanced opportunities. Detroit Mayor Duggan’s plan for the revitalization of that city in many ways follows such a strategy prioritizing the city’s limited resources on strengthening the city’s healthy neighborhoods (Detroit Future City, 2012). The enhancement of all habitat can include the provision and enhancement of parks and other open space uses.

It may be possible that privately-owned vacant lands within areas of suboptimum or marginal habitat can be traded for publicly owned vacant lands of

equal value in areas of optimum habitat. In this way, future development can be concentrated in areas of optimum habitat, thus reducing environmental stress on the population and improving access to resources and opportunity. Such a system could be gradually implemented and voluntarily avoiding issues of the kind of displacement found in the urban renewal programs of the 1960s, such as in the Mill Creek Valley of St. Louis. Such an approach is currently being considered in Detroit.

Current disaster relief insurance funds and loans from the Federal Emergency Management Agency are available for home and business repair or replacement. The Small Business Administration similarly offers low-interest disaster loans. While both programs allow these funds to be spent on relocation but do not expressly encourage or incentivize relocation outside of hazard areas. Utilizing a Habitat Quality Map and a Vacant Land Management Strategy Map as a guide, disaster relief policy makers can direct funding and future land use toward more resilient and sustainable solutions.

#### **7.2.2.1 What Were the Findings from the Methodology?**

In New Orleans, 22 percent of the vacant publicly owned parcels could be converted to uninhabited land uses including open space to ensure that the city's land use pattern is consistent with the underlying natural condition. In St. Louis that number is 11 percent. The conversion of publicly owned vacant lands is thus one component of the solution to the challenge of vacant lands. Parks and land uses, such as urban agriculture, are helpful but not the sole solution. Given the importance of opportunities, and in particular employment, if urban agriculture were able to substantially contribute to employment its value in addressing the challenges of publicly owned vacant lands would be enhanced.

Furthermore, the ParkScore data of the Trust for Public Land suggest that except in limited areas of both cities, new parks are not needed. However, this data

may not fully consider the impact of park quality on habitat quality. Simple proximity to open lands may not be sufficient to improve habitat quality without accompanying facilities and programs. Improvement of existing parkland is still warranted.

#### **7.2.2.1 How Were the Findings Corroborated?**

Several researchers have examined how opportunities or risks impact land values, though none specifically have examined these factors in the context of land vacancy. In addition, publicly owned land vacancy was highly related to the Opportunity Maps produced by the Kirwan Institute and the Social Vulnerability Index created by the Center for Disease Control. The analysis of both the Kirwan Institute and Center for Disease Control data show that vacancy is highly related to lack of opportunity (distance from resources) and proximity to risks (including the presence of environmental stressors).

#### **7.2.2.1 What is the Comparison Between the Two Cases?**

Much of New Orleans is built on former swamp and marsh land below sea level and is subject to flooding particularly during hurricane events. Land vacancy is highly related to these flood prone areas. Though *Homo sapiens* have adapted the environment over the centuries to meet their needs by building levees and pump systems, a review of the environmental history of the city suggests that these systems will eventually fail. In New Orleans, a long-term strategy to convert environmentally sensitive lands to an uninhabited use can prevent placing of major portions of the population in harm's way. Conversely, the development of St. Louis was largely in concern with the environment found by early settlers. Some drainages, such as Mill Creek, were substantially modified, the risks that impact vacancy in St. Louis are primarily *Homo sapiens*-made through management decisions and social planning. These same management decisions and social planning efforts were also present in New Orleans. In addressing land vacancy, both cities would be well



advised to work systematically to address the negative impacts of these management decisions and social planning efforts.

### **7.2.3 Question Three: Drivers of Land Vacancy**

#### **7.2.3.1 How Was the Question Investigated?**

This research began with a literature review to generate a list of opportunities and risks. The literature review identified which of these opportunities and risks had been considered by other researchers in the past as an indicator of public health and well-being. The research also considered the work of research organizations such as the Reinvestment Fund, the Center for Disease Control, and the Kirwan Institute that have sought to define community health and well-being through the creation of geographic information system databases. Each opportunity and each risk was then examined individually by overlaying a map layer indicating publicly owned vacant land parcels in a reductionist way. The number of vacant lots in optimum, suboptimum, and marginal habitat were the counted for each factor. Those with significant relationship to land vacancy were included in the Habitat Quality Maps. Publicly owned Vacant land parcels were then compared by map overlays to the two Habitat Quality Maps (Pre-Settlement and Present) to understand the combination/synthesis/interaction of these factors. While such an examination was useful, there is danger in such a reductionist approach.

Systems almost always have the peculiarity that the characteristics of the whole cannot be deduced from the most complete knowledge of the components, taken separately or in other partial combinations (Mayr, 1982). The breakdown of reality into the silos of knowledge represented by these fifty-one factors of habitat quality, provides a means to understand a complex reality, but it is an artificial breakdown. Further research is needed to synthesize the factors and to explore the relationship between them in contributing to habitat quality and in turn publicly owned land vacancy.

#### **7.2.3.2 What Were the Findings From the Methodology?**

The Pre-Settlement and Present Habitat quality models for New Orleans and St. Louis demonstrated relationships between publicly owned land vacancy and suboptimum habitat and between publicly owned land vacancy and marginal habitat. These results demonstrated the value of the habitat quality models as a probabilistic.

#### **7.2.3.3. How Were the Findings Corroborated?**

Several scholars have examined the impact of opportunities and various risks on public health and well-being, though not specifically focused on their influence of these factors on publicly owned land vacancy. The findings of this thesis are supported by the work of the Kirwan Institute and their opportunities mapping initiative, the Social Vulnerability Index of the Center for Disease Control, as well as, the PolicyMaps of the Reinvestment Fund on land values in New Orleans and St. Louis.

#### **7.2.3.4 What is the Comparison Between the Two Cases?**

The drivers of publicly owned land vacancy in shrinking cities are a combination of factors: the absence of opportunities critical to good habitat (including employment or sources of income, access to a food supply or the presence of food deserts, and the lack of capital and operating investment) and the presence of risk (including proximity to major highways, railroads, industrial areas, and various forms of pollution).

By overlaying a map of publicly owned vacant land parcels over opportunity maps created by the Kirwan Institute, the relationship between opportunities and land vacancy are examined. This research found that distance (or lack of proximity) to some opportunities was a stronger indicator of land vacancy than others. Proximity to employment opportunities and educational quality are highly related to occupancy, vacancy from these opportunities is highly related to vacancy. The presence of food deserts and the lack of locally serving retail and services is also highly related to vacancy. Residents of both New Orleans and St. Louis were found to have equal access to energy supplies.

Distance (lack of proximity) from cultural resources and views were not a strong indicator of vacancy. Proximity to parks and open space did not insure occupancy. The east side of City Park in New Orleans, for example, contains some of the highest vacancies in the city. A similar condition was found surrounding Fairgrounds Park in Northside St. Louis. The benefit of proximity to public parks appears to decay quickly with distance. This showed a limit to the value of open space as a city shaping tool.

This research found that some risks including PM 2.5 and ozone pollution did not have a significant relationship with vacancy. These risks are generally ubiquitous in the city and are not differentiated spatially. Vegetation was found to have no relationship with vacancy, with historical plant associations having little persistence over the history of New Orleans and St. Louis. Slope did not prove to be a constraint to development in either New Orleans or St. Louis. The site of New Orleans is virtually flat, while the slopes of St. Louis have been anthropomorphically modified through the centuries as the soft loess soils are easily shaped by *Homo sapiens*. However, one can imagine that in other cities where the soils and bedrock were not so easily shaped, topography and steep slopes are a major consideration in land vacancy. This understanding showed the need to calibrate and tailor the Habitat Quality Model to each individual city. It was shown that while the methodology could be applied in differing situations, the specific inputs vary.

In New Orleans, the number of publicly owned vacant lots is substantial and the overwhelming number of vacancies were highly related to geophysical constraints like flooding and subsidence. In this situation, publicly owned vacant lands are best returned to uninhabited uses such as open space or wildlife habitat and not slated for re-development. Conversely in St. Louis, vacant lots in conflict with geophysical constraints were only a fraction of the total. Here, issues such as social planning and management decisions like racial zoning, racial covenants, redlining, and urban renewal, as well as proximity to industrial lands and major infrastructure have played a major role in vacancy. In this condition, these publicly owned vacant

lots are imminently developable and might be put to an interim use like agriculture or forestry as a land holding strategy for future redevelopment.

This thesis showed that the influence of risks varied between communities. Geophysical risks, proximity to industrial sites, proximity to infrastructure such as major highways and railroads, and the resulting pollution from these industrial sites and technology had a greater impact on land vacancies than such factors as flooding and subsidence. Some land should more logically be converted to uninhabited land uses rather than return residents to risk of hurricanes, flooding, earthquakes, and other geophysical risks. Publicly owned vacant lands are often quite suitable for development, yet proximity to industrial lands reduces their value to a point that they are not attractive for redevelopment. In some communities like New Orleans, substantial portions of the city's vacant land inventory were found to be in conflict with geophysical constraints and should be converted to uninhabited lands in order to modify the disturbance pattern of the city.

#### **7.2.4 Question Four: Balancing Urban Form and Contemporary Population**

How might the physical form and infrastructure of a city be balanced or adjusted to its contemporary population?

##### **7.2.4.1 How Was the Question Investigated?**

This thesis digitized historical maps of New Orleans and St. Louis in ten-year increments from the founding of the city to present. The urbanized area of the city was digitized and the area calculated. Tables were created of population, land area, and population density of New Orleans and St. Louis in ten-year increments from the founding of the cities to present day.

##### **7.1.4.2 What Were the Findings from the Methodology?**

Based upon this analysis, the population density of New Orleans peaked in 1960 at 29.26 persons per acre. The population density of St. Louis peaked in 1950 at 20.29 persons per acre. If all the publicly owned vacant lands currently found in both cities that were identified in the Present Habitat Quality maps as marginal habitat

were converted to uninhabited land uses, there would still be sufficient land to accommodate the city's current population without exceeding the peak population density during the city's history. At peak densities, the current population of New Orleans could be accommodated on 11,750 acres (54.8 percent) instead of the 21,446 acres that are currently occupied. The current population of St. Louis could be accommodated on 15,558 acres (36.8 percent) instead of the 42,230 acres currently occupied. This would allow a much smaller land area to be served with infrastructure and services at lower cost to the city, an important consideration given the reduced tax revenue of both cities.

One major challenge is that the pattern of development and land vacancy in shrinking cities is a patchwork. While it is physically possible to accommodate the current population of these cities in a smaller area than the historical footprint of the city, a system is needed to encourage such consolidation. Development is easily served by infrastructure and services if uninhabited lands are consolidated into larger patches and put to more efficient use – agriculture, forestry, wildlife habitat, stormwater management or new urban development. It has taken 300 years for New Orleans to reach its current state. One might speculate it would take at least a similar period of time to evolve to an urban environment in greater concert with geophysical conditions and a more spatial equity urban form.

#### **7.1.4.3 How Were the Findings Corroborated?**

A search reviewed annual tax revenues collected by the City of New Orleans and City of St. Louis over the time series of analysis. This information was not available. Nor was an analysis of the cost of shrinking cities found for either city. However, one data point is that the City of New Orleans population went from 354,850 to 379,006 and then was essentially flat from 2009 to 2013. However, during that time all revenue collected by the city declined approximately 20 percent. Conversely, from 2006 to 2010 the St. Louis population went from 353,837 to 319,258. Tax revenue over the same period increased 1.7 percent per year, less than the consumer price index. Adjusted for inflation, tax revenue collected by the City of St. Louis declined over this period. These examples illustrate the challenge of

shrinking cities to provide infrastructure and city services with declining tax revenues. If revenues decline, costs must also decline, thus creating a spiral of disinvestment which reinforces decline.

#### **7.2.4.4 What is the Comparison Between the Two Cases?**

Though the current population of New Orleans and St. Louis can be accommodated on optimum habitat without exceeding the peak population density of the city, the challenge is how to encourage or incentivize residents to relocate to these areas. The intense negative reaction of New Orleans residents to the “Green Dot” map created by the Urban Land Institute following Hurricane Katrina illustrates this challenge. Change is difficult and the forced or coerced relocation of residents of both New Orleans and St. Louis through management decisions and social planning efforts throughout the history of both cities helped create the land vacancy problem in the first place. This observation suggests that any change must be slow, must consider the desires and concerns of residents, and must be voluntary and incentivized.

#### **7.2.5 Question Five: Property Values as Indicators of Land Vacancy**

A key issue raised during this thesis was whether real estate prices incorporate the market’s assessment of opportunities and risks. This research demonstrates that property values are an indicator of land vacancy.

##### **7.2.5.1 How Was the Question Investigated?**

Maps prepared by the Reinvestment Fund of land values in New Orleans and St. Louis were overlaid with maps of publicly owned land vacancy. A visual comparison was made between land vacancy and property values. The vacant land parcels by real estate values were counted and the percentage of the total calculated.

#### **7.2.5.2 What Were the Findings from the Methodology?**

The relationship between land values and publicly owned land vacancy was demonstrated to be strongly related.

#### **7.2.5.3 How Were the Findings Corroborated?**

The findings of the Reinvestment Fund analysis were corroborated by comparing assessed valuation of land to land vacancy. In both analyses, the relationship between land values and land vacancy were shown to be strongly related.

#### **7.2.5.4 What is the Comparison Between the Two Cases?**

Low real estate values are highly related to publicly owned land vacancy. It was hypothesized that if demand for real estate is strong enough, some levels of vacancy occur as some level of turnover is present.

### **7.2.6 Question Six: Community Concerns and Physical Restructuring**

#### **7.2.6.1 How Was the Question Investigated?**

Maps of land vacancy were overlaid over maps of the various social risk factors including educational quality, crime rates, race, median household income and unemployment to examine the impact of neighborhood effects on land vacancy.

#### **7.2.6.2 What Were the Findings from the Methodology?**

Findings for both New Orleans and St. Louis demonstrated a strong relationship between educational quality, crime rates, race, median household income and unemployment to land vacancy.

#### **7.2.6.3 How Were the Findings Corroborated?**

Land vacancy in New Orleans and St. Louis was highly related with opportunity as mapped by the Kirwan Institute corroborating the results of the habitat quality model.

#### **7.2.6.4 What is the Comparison Between the Two Cases?**

Should community issues such as the configuration of neighborhood units be determining factors for physical restructuring? Neighborhood effects including high levels of crime are highly related to vacancy. Planners and policy makers are well advised to work to strengthen access to opportunities and to reduce risks.

### **7.3 Conclusion**

#### **7.3.1 Original Contribution to Knowledge and Understanding.**

Although hedonic models have explored the relationship between real estate values and specific factors such as proximity to quality education, this thesis proposes the development of a habitat quality model for *Homo sapiens*. While similar effort such as the opportunity mapping efforts of the Kirwan Institute address similar issues, the efforts contained in this thesis specifically seek to define the analysis in biological terms to define habitat quality. This thesis identifies real estate values as an indicator of publicly owned land vacancy and suggests real estate values as an indicator of habitat quality.

#### **7.3.2 Setting the Research into A Wider Perspective**

As suggested by the literature review, there are no known comprehensive models of habitat quality for *Homo sapiens*, as there are for many other species. This thesis provided a theoretical framework for consideration. Further refinement of the framework would include the ability to weight factors based upon a more thorough understanding of each factor's impact on habitat quality. Additional geophysical, social, and technological factors as identified should be built into the framework. The framework would also be further refined by utilizing surveys of urban residents to rank order and weight the importance of various resources and the impact of various stressors. Surveys conducted in each case study city should help to understand local and cultural differences.

One challenge presented in establishing a habitat quality model that is based upon proximity to opportunities and risks is that each factor was shown to exhibit



different distance effects. While the model is useful, a more sophisticated model calibrated to the distance effect of each factor was beyond the limits of this study.

Further research to test and refine a Habitat Quality Model for *Homo sapiens* offers great promise for landscape architects and related fields. A habitat quality model suggests that the process of design might be considered as the process of designing quality habitat for *Homo sapiens*, as well as, other species. Design interventions can be “experiments” if baseline metrics are established and the impact of interventions measured and analyzed over time. For example, can we test how new parks, traffic calming, or brownfield remediation, impact land vacancy?

This thesis applied theories of disturbance patch dynamics to consider if urban development in conflict with geophysical constraints leads to the persistence or duration of ecological patches incompatible with *Homo sapiens* health and well-being. Similarly, this thesis considered if development in harmony with geophysical conditions creates conditions of persistence that benefit *Homo sapiens* health and well-being. This thesis also examined if *Homo sapiens* management activities support the persistence of patch conditions in ways that are at times beneficial to *Homo sapiens* health and well-being, and at other times harmful. Future research should consider such questions as minimum patch size and edge configuration.

This thesis illustrated how major highways and railroads fragment habitat for *Homo sapiens*. Wildlife ecologists work to create corridors and linkages to connect habitat patches for a variety of species. Research is suggested to determine the importance of corridors and linkages for *Homo sapiens* habitat as well. Many questions are still being answered. What are the minimum characteristics of suitable linkages? How, for example, does traffic volume, speed, roadway width, block dimensions, and roadway character link or fragmented habitat? At what point does a roadway, in terms of traffic volume or road width, become a barrier and fragment habitat? At what point does a complete street serve as a linkage between patches of *homo sapiens* habitat? Similar research should be applied to pipelines, powerlines, and railroad corridors.

Identifying a city's underlying geophysical condition is not sufficient to transform it. There are other questions to be answered and issues to be resolved which are beyond the scope of this research. Regulatory environments, such as zoning, annexation and tax policy, often do not support environmental restoration and tend to preserve the *status quo*. In many cases, geophysical systems have been dramatically modified, often at a considerable public and private expense. In growing cities, high real estate values have often been assigned to formerly sensitive environmental lands. In growing cities, the cost of creating new open space can often be offset by the increased value of adjacent real estate. In a shrinking city, however, there is little to no demand for new development.

The background research and accumulation of base data, including the gazetteer and related meta-data for historical maps and demographic information for both St. Louis and New Orleans, creates the groundwork for future research on this topic. This data has been deposited in the University of Edinburgh Research Archives to facilitate the work of future researchers. The assembled data provides one of the most comprehensive databases of geophysical and social data known to exist for New Orleans and St. Louis. Additional research is needed to understand opportunities, such as energy flows, and risks such as the impacts of hurricanes and tornadoes, to create more comprehensive and detailed Habitat Quality Models.

Identifying and assembling sources of data for these fifty-one factors was a major task. This effort now makes replication of the methodology for future researchers far easier and facilitates the application of the framework to other cities, both shrinking and growing.

There are numerous examples from around the world of the daylighting of streams and other similar environmentally-focused projects. To date, however, there are no examples of the comprehensive application of environmental history to an entire shrinking city. The major known examples of such works are of New York City and San Francisco, both rapidly growing cities. The implementation and

monitoring of the conclusions of this thesis would provide a means of field verifying the conclusions of this study.

An analysis of Opportunity Maps generated by the Kirwan Institute found that some publicly owned land vacancy in New Orleans (14.2%) and St. Louis (2.9%) exists in areas of very high or high opportunity. Additional research is needed to understand the causes of this vacancy. One hypothesis is that a portion of this vacancy is simply the transactional nature of real estate markets. Publicly owned vacant land offered for sale has simply not yet sold. Some sites may have constraints that are not apparent from the available data. Another is that the neighborhood effects found in suboptimum or marginal habitat may have a distance effect, influencing vacancy patterns in otherwise healthy adjacent areas. It may also be that the Kirwan opportunity maps do not incorporate all of the factors that influence opportunity into their analysis.

Although this thesis examined the relationship between parks and publicly owned land vacancy, a more in-depth analysis of the influence of urban design on land vacancy is warranted. Much of the vacant areas of New Orleans and St. Louis are areas with walkable block lengths, appropriately scaled streets, alley accessed residential homes, neighborhood scale retail centers, and civic amenities such as schools and churches, and historical architecture with porches and a strong building/street relationship. In short, these neighborhoods display many of the same design principles as exposed by new urbanist design principles. With the loss of population, many of these churches, schools, and retail areas have closed. Such relationships suggest a limit to form-giving as a city shaping tool. Additional, research is needed to explore the relationship between physical design, placemaking, and land vacancy.

### **7.3.3 Limitations of the Study**

The research contained within the thesis was limited by the availability of data for the larger metropolitan areas of New Orleans and St. Louis. Metairie, adjacent to New Orleans and East St. Louis, across the Mississippi River from St.

Louis are also shrinking cities. Data on publicly owned vacant land parcels was not readily available for these two cities or other municipalities within the larger Metropolitan Statistical Area (MSA) of New Orleans and St. Louis. Such data would have provided a more comprehensive understanding of land vacancy in these two cities.

The lack of time-series data for real estate values and land vacancy over the entire length of the history of New Orleans and St. Louis is another limitation of the study. While sufficient information was available to provide an understanding of environmental history and publicly owned vacant land policy, if the methodology utilized in this thesis is to provide value as a diagnostic and planning tool for shrinking cities, an analysis of a longer time-series would be of value. This ensures that observed relationships are persistent and not temporary in nature.

Two cities are utilized as case studies in this thesis. A more thorough understanding of land vacancy in shrinking cities is gained by examining a third case study. Based upon the criteria utilized to select the first two cities examined in this thesis, Detroit, Michigan, is recommended as the third city for examination because of its similar cultural history to New Orleans and St. Louis, as a city in the Union during the American Civil War perhaps a different racial history. However, much could be learned by comparing New Orleans and St. Louis to a growing city. In this regard, Houston, Texas, which received the bulk of New Orleans out-migration following Hurricane Katrina would be an excellent choice as a third case study.

It is acknowledged that New Orleans and St. Louis as shrinking cities, are in many ways the product of post-Fordism, Fordism refers to the system of mass production and consumption characteristic of highly developed economies during the 1940s-1960s. As the role of cities have changed over time, it would be useful to apply the framework to a growing city of the knowledge based economy such as San Francisco or one of the newer rapidly growing cities of the San Francisco Bay area which lacks an industrial past.

The Habitat Quality Model employed in this thesis was a simple additive model. Opportunities and risks were not weighted based upon their relative importance. One way to create a weighted model would be to use public values derived from public surveys, such as price and distance from risk, as way of testing the thesis that land values are an indicator of poor habitat quality. This could be particularly valuable in assessing the impact of views and urban design on habitat quality.

The study did not seek to confirm the conclusion of the research with the local population of New Orleans and St. Louis. Change is a difficult social and political process and can only be made with the education and support of the population. A survey that tests public opinion to determine what the public considers to be high quality habitat would be one way to identify any important opportunities (resources) or risks (environmental stressors) that were overlooked by this process. The Habitat Quality Model could be further calibrated by prioritizing the relative importance of resources and stressors and weighting the model according to public values.

Other opportunities and risks may be appropriate for inclusion in future Habitat Quality Models. For example, how does proximity to major universities, major cultural institutions, or major entertainment or sports venues factor into land vacancy? Conversely, proximity to power plants, landfills, waste incinerators, pipelines, or major powerlines might also influence vacancy. Although recognized as potentially influencing vacancy, none of these factors were included in this analysis. Other neighborhood effects such as cultural diversity or the education level of the population might also be influential. Future research should test a wider range of opportunities and risks of habitat quality for *Homo sapiens* and upon land vacancy.

A full understanding of the challenges of shrinking cities would be aided by an understanding of the economics of shrinkage. How much have tax revenues to the City of New Orleans and City of St. Louis changed in inflation-adjusted terms relative to the change in population? What are the costs of serving a physical infrastructure built to accommodate a much larger population with declining tax revenues? Further research in this area is needed.

#### 7.1.4 Further Concerns

Throughout the history of New Orleans and St. Louis, lower income populations have found opportunities for housing on marginal lands. The Lower Ninth Ward in New Orleans is one such example. While often providing the only affordable locations for housing, populations in these locations are in harm's way from flooding, geologic hazards, industrial pollution, or the impact of major highways, railroads, and other major infrastructure. Efforts to understand the elements of quality habitat for *Homo sapiens* offers the potential to create spatial equity, address issues of environmental justice, and provide a higher quality of life for all populations. However, further research is needed to know if higher quality habitat can be provided to the entire population of a shrinking city at affordable prices.

An examination of the histories of New Orleans and St. Louis suggests a path forward for shrinking cities that provides a slow and deliberate transformation of a city rather than dramatic abandonment of entire neighborhoods or the relocation of existing populations. New Orleans has taken almost 300 years to evolve to its current form. St. Louis over 250 years to reach its current form. It may take a similar length of time for the cities of New Orleans and St. Louis to evolve into cities in concert with its historical ecology.

If *Homo sapiens* do indeed behave subject to the same biological principles that guide other species, competition for habitat will continue. As a sentient species, government intervention is needed to ensure that the contestation for habitat possesses the fairness and equity not found in other species (Fainstein, 2011). Equitable access to employment, education, and housing must be insured, as well as, equitable freedom from risk. In the absence of strong markets, government investment will be required to address inequity and eliminate technological risks. Legal action is needed to ensure that the perpetrators remediate damaged landscapes.

*Homo sapiens* adapt to and shape the environment, continuously contributing to landscape transformation. Piecing together landscapes requires a

sometimes-difficult union between the natural and social sciences, close attention to geographic and temporal scales, and knowledge of the range of *Homo sapiens* ecological complexity. At the same time, landscape architects, allied professionals, and other decision makers must be mindful of the perils of path dependencies and the potential for their actions to become negative disturbances in their own right.

There is in this work a search for fundamental, existentialist principles which determine the relationship between *Homo sapiens* and their urban habitat. Such a search might be interpreted as ahistorical, without knowledge or concern for history or tradition. But this work has at its foundation an understanding of the environmental history of New Orleans and St. Louis. Such knowledge is essential to understanding the decisions that have created the urban habitat that exists today. A knowledge and consideration of history does not mean that there are also not fundamental, existential principles at work as well. *Homo sapiens* seek high quality habitat and compete with each other and with other species for this habitat. A study of history suggests that landscapes and the habitats they provide have always been and will always be contested. That is the nature of all species including *Homo sapiens*. In these contested landscapes, spatial equity is desirable to improve the well-being of all members of the species but may not be attainable.

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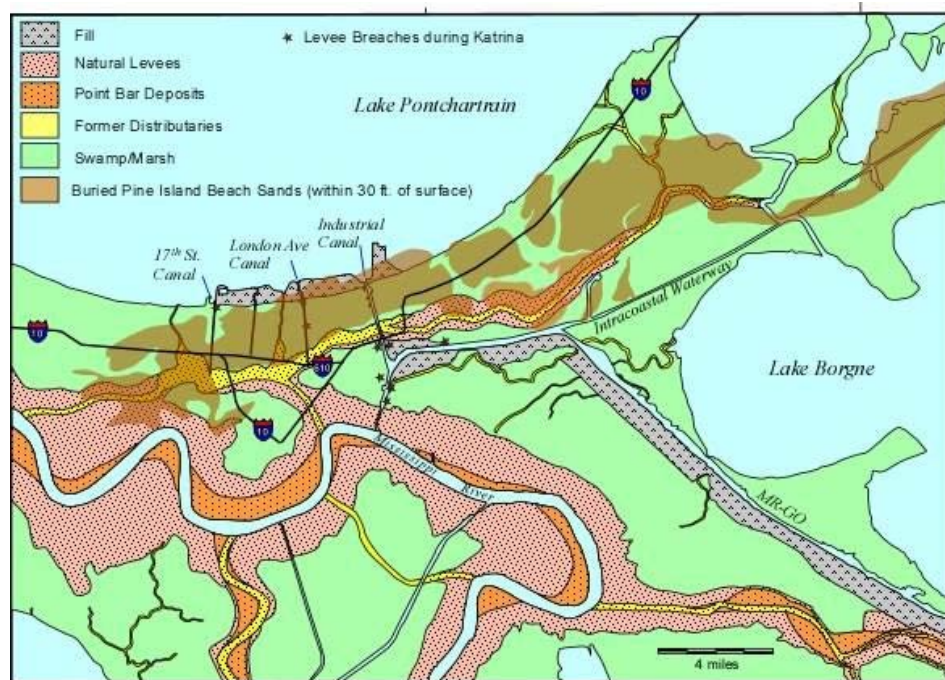
## **Appendix A – An Environmental History of New Orleans**

### **A.1 Environmental Setting**

New Orleans has been described as a city with a marvelous situation but a terrible site. Founded by Jean Baptiste Le Moyne, Sieur de Bienville, the city was extremely well situated to control commerce throughout the entire Mississippi River basin yet its site condition repeatedly subjected the residents to flood and hurricane damage (Figure 103). The Mississippi River drains an enormous area of the continental United States, reaching within 300 miles of the shores of the Atlantic Ocean to roughly 500 miles of the Pacific, a basin of approximately 1,200,000 square miles, or more than 40 percent of America. The river delta on which New Orleans sits is formed by what geologists call “dynamic sedimentation,” and much of the delta remains a wetland wilderness. Researchers have pointed to the ability of river floodplains to create dynamic patch mosaics (Southwell, 2008), and this was a critical factor in selecting New Orleans as a case study for my research. If there is one element that defines the deep structure of New Orleans, it is the Mississippi River.



and has provided the city's only suitable foundation for building on the soggy ground of the river's deltaic region (Figure 104). The founders' initial settlement, now called the Vieux Carré or French Quarter, was a grid, six blocks deep and twelve blocks wide. From the apex of the natural ridge, the terrain sloped toward a cypress wetland at the settlement's rear. Beyond this "back swamp" (which was as much as ten feet below sea level), lay what is now called Lake Pontchartrain. The farther one traveled away from the river and into present-day New Orleans, the lower the ground. Suitable land for urban development extended less than two miles from the waterfront to just beyond what is now Claiborne Avenue. Beyond this point, the back swamp to the shore of Lake Pontchartrain was interrupted only occasionally by bayou ridges. One of these ridges, the Metairie Ridge, became the site of a neighborhood for those of higher incomes in the city. The high natural levee bayou ridges and back swamp also form part of the deep structure of the city and have created patches with ecological, economic, and social implications that persist to this day.



Based on Army Corps of Engineers Geologic Maps

Figure 104: Geological Map of New Orleans

New Orleans and surrounding areas continue to sink at highly variable rates due to a combination of natural geologic and human-induced processes (Figure 105). The highest rates of sinking were observed upriver along the Mississippi River around major industrial areas in Norco, and in Michoud, just east of New Orleans with up to 2 inches (50 millimeters) per year of sinking. Notable subsidence has also been observed in New Orleans' Upper and Lower 9th Ward neighborhoods, and in suburban Metairie, where the measured ground movement could be related to water levels in the Mississippi. At the Bonnet Carré Spillway on the Mississippi River east of Norco, New Orleans' last line of protection against periodic springtime riverfloods that could overtop the levees, research showed subsidence of up to 1.6 inches (40 millimeters) a year of sinking behind the Bonnet Carré's structure and up to 1.6 inches (40 millimeters) a year at nearby industrial facilities. While there are many contributing factors for the regional subsidence, including the decay and compaction of formerly marsh and swamp soils, the primary contributors have been determined to be groundwater pumping and de-watering (surface water pumping to lower the water table, which prevents standing water and soggy ground) (Jet Propulsion Laboratory, 2016). This subsidence, which damages home foundations, roadway pavements, and underground utilities, slowly places these land areas further and further below sea level and makes them increasingly vulnerable to flooding. Logic suggests that development on these former marsh and swamp lands is not sustainable.



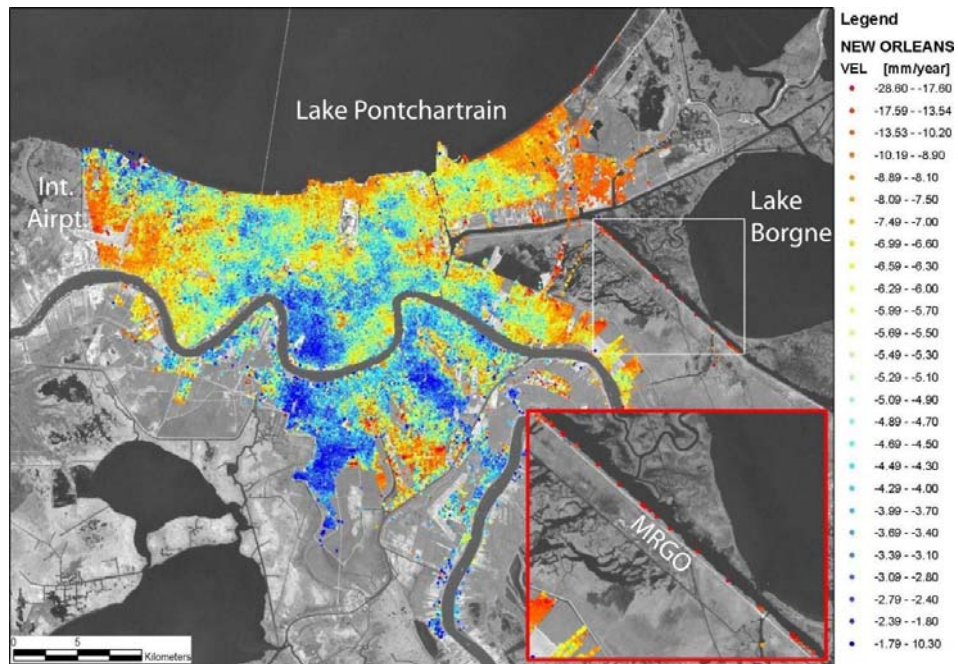


Figure 105: Subsidence Map of New Orleans

### A.1.2 Hydrology

The Mississippi River scoured what is known as its West Bank (this area is the southern boundary of the river) as it makes its turn through the crescent (and it is this ‘crescent’ that gives the city its colloquial name, the “Crescent City”). Just upriver from the French Quarter, the river deposited its silt in relatively calm water, slowly forming a natural levee which sloped to a “back swamp” some distance from the river. It is upon this natural levee that the wealthiest districts of the city, notably the Garden District, were constructed. While it is not clear if the principle of “upriver, uphill, and upwind” guided the creation of the Garden District, these conditions exist nonetheless.

The site of New Orleans was the gateway to fifteen thousand miles of navigable waterways. In selecting this strategic location for the city, Bienville did not consider the dynamics of fluvial tectonics, accretion and erosion, deltaic formation, and floodplains; nor did he know the extent to which the river extended into North

America. As with an understanding of the geology of St. Louis, the hydrologic science necessary to understand the site conditions did not exist at the time of the city's founding. It is said that Bienville focused on the city's situation and ignored the hazards of its site. Geographer Peirce Lewis defined situation as "what we commonly mean when we speak of a place with respect to neighboring places." The site of New Orleans, as Lewis described, "the actual real estate which the city occupies," has continually challenged residents since the beginning of the city. This conflict between New Orleans' situation and its site is referred to by geographer Richard Campanella as "Bienville's Dilemma"

### **A.1.3 Vegetation**

There have been few paleo-ecology studies of the New Orleans area and southeast Louisiana (Reese, Liu, 2001). A review of historical maps of New Orleans and of south Louisiana, as well as historical accounts, suggest the site of what is now New Orleans would have been predominantly southern alluvial backwater cypress (*Taxodium spp.*) and black gum (*Nyssa sylvatica*) swamps, with hardwood forest predominating the natural levee along the Mississippi River, Bayou St. John, and Bayou Sauvage. These hardwood forests likely consisted of red maple (*Acer drumondii*), sweetgum (*Liquidambar styraciflua*), green ash (*Fraxinus pennsylvanica*) hickories (*Carya spp.*), elms (*Ulmus spp.*), and oaks (*Quercus spp.*).

With the arrival of European settlers, this cypress swamp over time declined as land was cleared for agriculture and to provide lumber for building of the city. The dredging of navigation canals including the Old Basin (Carondelet) and New Basin canals, as well as the construction of levees, changed drainage patterns and reduced the presence of *Taxodium* and *Nyssa* species which depend upon periodic flooding.

Other areas of what is now Orleans Parish and the City of New Orleans were marshes. While swamps are typically defined by the presence of woody plants, marshes have no woody plants and are occupied by saltmarsh grasses, reeds, and sedges. Marshes are typically not as deep as swamps, both of which have fluctuating levels of

water. Both swamps and marshes can be fresh water, salt water, or brackish (a combination of both). Like all landscapes, the environment of the New Orleans vicinity is dynamic, with changes resulting from the impacts of hurricanes, non-native species (plant and animal), and the interventions of human development.

The greatest change in vegetation patterns occurred following the development of the Wood Screw in 1916 (named for its inventor, A. Baldwin Wood, a local engineer) when vast areas of former swamps and marshes in the areas equidistant from both the river and the lake were drained for real estate development. As with St. Louis, the vegetation of New Orleans was not a primary constraint or shaper of city form but rather an indicator of the topographic and hydrologic factors which did shape the form of the city. The Jean Lafitte National Park and Preserve in Marrero, Louisiana, just east of New Orleans, provides an example of what the marshes and swamp lands of the original site of New Orleans would have been. Except for numerous old and enormous live oak trees in City Park (the location of the largest grove of mature oak trees in the world, some of which are between 600 and 900 years old), virtually no old growth forest remains within the City of New Orleans. Because plants thrive here and the landscape of New Orleans is always so lush (save for the occasional freeze or hurricane), vegetation is an ever-present, if often under-appreciated, site condition, though certainly one with substantial value for its aesthetic and ecological contributions. In fact, the local landscape and its evolutionary history has only recently been explored with any depth or substance, precisely, per one local landscape historian, because of its ubiquity (Douglas, 2011).

Though the vegetation patterns of the city have changed dramatically over time, the tree canopy of New Orleans is an essential part of the city's character and contributes dramatically to the quality of life in the city (Lutsky, 2016). A significant number of trees - calculated at 9.6 percent - were lost in Hurricane Katrina (Schliefstein, 2012) but public and nonprofit recovery efforts have replaced lost trees and even increased the city's tree inventory.

#### **A.1.4 Native People**

It is perhaps a reflection of New Orleans as a site for *Homo sapiens* habitation that Native Americans primarily used the site only seasonally in the period before European settlement rather than establishing permanent settlements (Native Heritage Project, 2016). Native Americans did travel the Metairie and Gentilly ridges via trails for hunting, fishing, and trading. The word bayou derives from *bayuk*, the word for minor stream in the Choctaw language. They called the area Bayouk Choupic, after the mudfish and built thatched huts near its bank. In 1699, the Choctaw showed French explorers their trails. It was the portage route along Bayouk Choupic, renamed Bayou St. John by the French, from Lake Pontchartrain to the Mississippi River that made the site attractive to French settlers. The alignment of Bayou Road closely follows one of these ancient trails. Per local historian Jerah Johnson, the area's earliest, as well as its last, all-Indian market was held in an open area called the Place Bretonne at the intersection of these trails where present day Esplanade Avenue, Bayou Road, and Dorgenois, Bell, and DeSoto streets come together. The market lasted, with gradually dwindling numbers of Indians, after 1809 until the construction on that spot of the LeBreton Market building in 1867 (Hirsch, 1992). Few artifacts of native American activity have been found south of Lake Pontchartrain though some evidence confirms the presence of native Americans as early as 300-400 (FEMA, 2013).

Although the site of New Orleans was not a favored site for permanent settlement by Native Americans as was the site of St. Louis, it was the deep understanding of topography and the use of the Metairie and Gentilly ridges for trails and portage by Native Americans that led to the settlement of the city. These ridges are part of the deep structure of the city and the site of some of the city's most enduring neighborhoods.

### **A.1.5 European Settlement**

In 1719, the first of a large group of African slaves began to arrive in New Orleans mostly from West African Senegambia, beginning fourteen decades of slavery in Louisiana. In the 1780s a second major wave of slave importation added to these

numbers. Slavery profoundly influenced New Orleans's social and urban geography. In 1809, over 9,000 Saint-Domingue (Haitian) refugees, divided evenly among white, free people of color, and enslaved blacks, more than doubled the size of the city, reviving the city's Francophone culture, and adding to the layers of ethnic complexity. In 1810, the plantation of Claude Tremé was subdivided for urban development. Faubourg Tremé spread New Orleans into the back swamp and along the uplands of Esplanade Ridge and the Bayou Road. Although often described as America's oldest black neighborhood, it was populated by a mix of black, Creole, and immigrant populations. Creole is a term that has evolved over time in the City of New Orleans. Hirsch and Logsdon offer three definitions of Creole: 1) a person of European descent born in the West Indies or Spanish America; 2) a white person descended from early French or Spanish settlers of the United States Gulf states and preserving their speech and culture; 3) a person of mixed French or Spanish and black descent speaking a dialect of French or Spanish (Hirsch and Logsdon, 1992).

Groups of African slaves and free people of color, as well as European Americans of French, English, Spanish, Irish, and German descent settled in different parts of the city, each making a distinctive contribution to the city's character. The interaction of these groups with the environment and their chosen habitat patches have impacted their health and well-being for generations. As African Americans occupied the back swamp of New Orleans following the Civil War, they have experienced flooding and other disturbances for generations.

As early as 1736, when the Charity Hospital was relocated to a site along the back- swamp edge, the citizens of New Orleans have sought to locate objectionable and threatening uses to the "back-of-town." Early cemeteries, including the St. Louis Cemetery (1788) were situated outside the 'ramparts' of the colonial city.

The river's current allowed commerce to flow easily downriver from the American interior to New Orleans, but traders coming upstream from the Gulf faced a difficult challenge. Although the first substantial artificial levees were erected in 1722, major floods produced standing water in the French Quarter in 1785, 1791, and 1799. Anthropogenic river control ultimately succeeded in preventing annual floods but

inadvertently starved the larger delta area of critical sediments and fresh water. This practice has caused catastrophic land loss by the late twentieth century. Locals learned that though the river might deposit land in one location it could easily erode it in others without warning.

A crevasse, or breach, in the natural levee in 1816 flooded the back swamp. Ironically it covered the land with a layer of sediment, building up the elevation and facilitating the development of the Carrollton district. Known as the Carrollton Spur, a ridge likely formed with repeated crevasses near the current location of the Carrollton Avenue bend in the Mississippi River. Each burst of sediment-laden floodwaters through the riverbank built up the land, one layer at a time. (Mandelman, 2016). In 1849, another crevasse in the levee, this time at Sauv  Plantation, diverted river water into lowlands between the natural levee of the Mississippi and the Metairie/Gentilly ridges (Figure 106). The water inundated the city from the rear, damaging 2000 structures and displacing 12,000 residents. The Sauv  Crevasse ranked as the city's worst flood until the Hurricane Katrina levee failures of 2005.

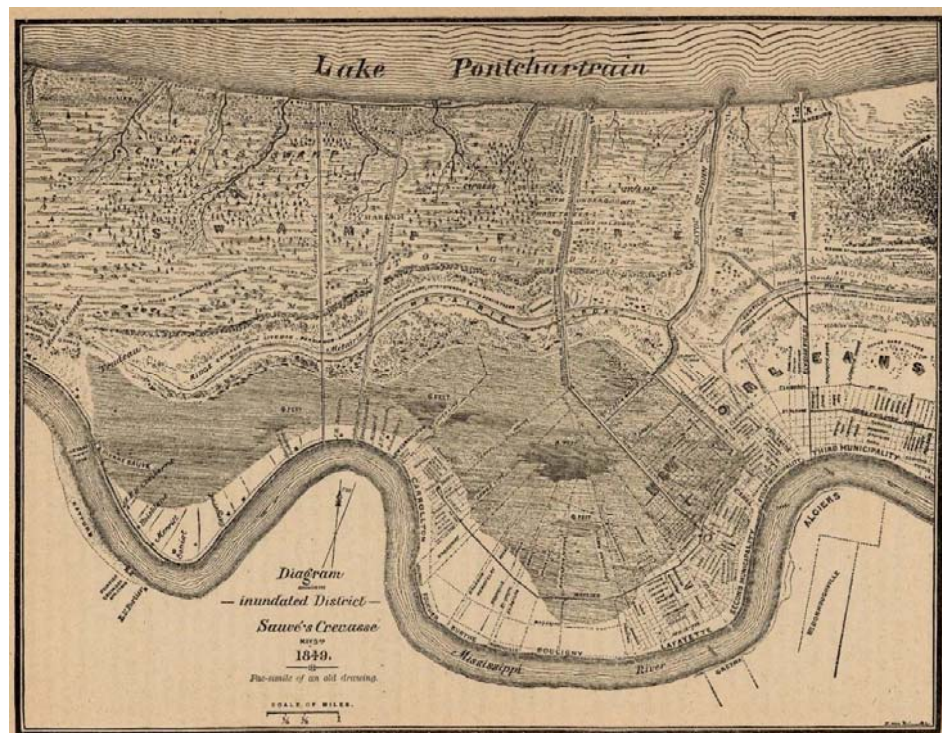


Figure 106: Map Of Sauve's Crevasse 1849

Residents believed that digging into the ground released foul, pestilential vapors (called "miasma") into the air which resulted in epidemics. Indeed, the low-lying areas of the city were subject to water-borne diseases such as yellow fever from the eighteenth to the early twentieth centuries. These lower areas contain major pockets of poverty within the urban fabric. In 1832, a cholera epidemic killed thousands. Much of the city lies below sea level and atop high ground water. Combined with the city's frequent rains, the city is under constant threat of catastrophic flooding. Elevation (or lack thereof) has been another of the key elements of the deep structure of the city, with economic well-being and *Homo sapiens* health defined by one's position relative to sea level.

During the summer of 1853 over 10,000 people died of yellow fever during a four-month period, at the time probably the worst single epidemic ever to strike a major American city. After 1810, a major epidemic in which at least 150 people died, had struck the city at least every third year. Another 4,800 New Orleanians perished to yellow fever in 1858, the city's second-worst plague.

In the years before the advent of germ theory, most doctors believed the roots of the epidemic lay in the vapors rising from the marshes or rotting organic matter. This theory of vapors or “miasmas,” led to other misconceptions such as the theory of local origin that



Figure 107: Yellow Fever Map Of New Orleans 1905

alleged the disease was spawned through spontaneous generation. Distance from port facilities and navigational canals provided some relief from water borne pathogens or pathogens brought by visitors to the city (Figure 107).



The production of the urban environment of New Orleans has been both a natural and social process. Indeed, any attempt to draw a line between the two is almost always futile (Kelan, 2003). Throughout its history, the citizens of New Orleans have sought to shape the city's site to match the promise of its situation. New Orleans is a city of commerce, and commerce abhors uncertainty. Over the centuries, residents have sought to impose their will upon the environment -- for instance, to regularize the river and its bank and to mitigate the effects of a high-water table -- with mixed results.

In addition to flood hazards, the city's location on the Gulf coast has subjected the population to frequent hurricanes. From 1776-1781 six hurricanes struck the city. A major hurricane in 1837 damaged structures and flooded the marshes adjacent to Lake Pontchartrain. In 1871, a crevasse at Bonne Carré sent river water into Lake Pontchartrain flooding the city up to Rampart Street, the worst flood since the Sauvé Crevasse. Other major hurricanes hit the city in 1888, 1893, and 1947.

Fires also had significant impacts on the city's evolution. The Good Friday fire of 1788 destroyed 856 buildings, leveling 80 percent of the city's structures, leaving 70 percent of the population homeless. A second major fire in 1794 destroyed an additional 212 structures. Thus, most of the city's eighteenth-century structures were destroyed and the urban fabric of subsequent periods reflected styles and tastes of those periods rather than those of the colonial period.

In 1788, the Faubourg St. Mary (now the Central Business District) was surveyed. In 1805, the Faubourg Marigny became the city's first expansion on the natural levee in the downriver direction. This neighborhood, known as the "poor Third" ward became home to a mostly working class Creole and immigrant population during the nineteenth century. In an age without central sewerage treatment systems, downriver and downwind often determined where the poor found their homes. The upriver plantations of Delord-Sarpy (Duplantier), Saulet (Solet), Robin, and Livaudais plantations were subdivided in the Faubourgs Duplantier, Solet, La Course, and L'Annunciation with working class housing near the river and grander homes inland. The neighborhoods today now form the lower Garden District. Throughout the city's history, one's position relative to the Mississippi also determined one's well-

being. Whether homebuyers consciously considered these factors is unknown, but a home upriver of the city's population and just inland from riverside industries separated one from pollution and nuisance industries.

During the period from 1810s to 1870s, the city continued to expand along the natural levee mostly upriver including faubourgs Nuns and Lafayette, as well as into the districts that include what is now Audubon Park and the university campuses, Greenville, Friburg, and Carrollton. In 1833, the City of Lafayette was founded upriver from the boundaries of colonial New Orleans. The community drew German and Irish immigrants to the densely populated riverside blocks (now the Irish Channel) and wealthy, mostly Anglo families to its interior blocks (now the Garden District). In 1835, one of the country's first street car lines, along present-day St. Charles Avenue, helped the development of these uptown districts.

From 1837 to 1860, New Orleans ranked only behind New York as a port of entry, and, during the decade between 1840 and 1850, New Orleans clustered with Baltimore, Philadelphia, and Boston as the cities with the country's second largest populations behind New York. During the 1830s, the black population (a majority since the 1730s) fell into numerical minority as Irish and German immigrants augmented the city's white population. Prior to the Civil War, urban slaves were often replaced by immigrant servants and laborers, contributing to the steady decline in absolute number of black New Orleanians from the 1840s to emancipation. The city remained a majority white population from the 1830s until the late 1970s (Campanella, 2007).

By 1861, so many immigrants had poured into the city that the population had exploded more than tenfold from the time of the Louisiana Purchase. On the eve of the Civil War, more than 250 steamboats plied the Mississippi system, making more than 3500 annual stops at the New Orleans waterfront. The power of steam encouraged city residents to seek to control and manage the river and the waterfront through technology. The decisions of this time to invest in costly, static infrastructure to control the river launched a path dependency which has made New Orleans less adaptable when facing ecological problems today. From 1830 to 1840 New Orleans

blossomed into one of the five largest cities in the United States, and the third biggest port in the world.

From 1825 to 1848, the construction of canals and railroads farther north in the Mississippi watershed began to reduce the importance of steamboat traffic and of New Orleans as a port. Materials began to move east/west through the country rather than north/south down the river. Commerce found the direct route to markets on the east and west coasts presented by the canals and railroads preferable to the indirect route provided by the Mississippi River and ships on the Gulf of Mexico and Atlantic. As William Cronan has stated, the sway of geography can be overcome by the logic of capital (Cronan, 2005). By 1853, the city had reached a population of approximately 120,000 year-round residents. The four-year blockade of the city during the Civil War contributed to even further to success for the railroads.



Figure 108: Barrons' Sanitary Map Of New Orleans

It has been argued that urban dwellers tend to occupy floodplains after structural flood prevention devices such as levees have been erected. In a classic

case of path dependency, the adoption of one key infrastructure system creates a dependence on that system, despite the adoption of building codes and other land-use approaches to flood protection.

In 1836, city leaders, unable to agree on how to administer the waterfront, split the city into three sub-municipalities. A fractured city government from early statehood to the mid- nineteenth century constructed three independent open canals fed by street drains to transport water from the high ground of the natural level to the back swamp behind. The principal aim of these and later-nineteenth-century projects was the removal of floodwaters washing over the city from the Mississippi River or Lake Pontchartrain and to reduce the amount of standing water and groundwater that contributed to public health problems and inhibited the city's growth. Only as the city achieved the primary objective did the secondary concerns become obvious. Simply put, once the bowl was securely in place, rain began to fill it. Protection against one flood hazard, the river, guaranteed the city's long standing struggle with the second, rainfall.

#### **A.1.6 Water Quality**

Because of its unusual topography, the city was subject to periodic flooding from the Mississippi River and Lake Pontchartrain, as well as frequent inundation from the high intensity rainfall.

Often, after one of these floods, the inhabitants were forced to wade through the streets or be rowed in small boats to take care of their daily business. Late 1884-1885 illustrations in the daily newspapers showed the main business section flooded with two to three feet of water as residents waded and rowed through the streets. It was not uncommon for such regular flooding to last for a week. In fact, many parts of the city were subjected to periodic flooding even after moderate rainfall.

Water for drinking or general use was either collected in large cypress cisterns that stored rain water from the roof tops or taken from the river and allowed to settle in

large earthenware jars. At the time, there were no purification or sterilization procedures. Without a municipal water supply, the greater part of the city burned to the ground in 1788 and again in 1794. Ironically, over 300 billion gallons of water a day were pouring down the Mississippi less than two blocks from the fire. This amount is more than the present amount that the city uses in six years.

A sewage collection and disposal system was also non-existent. *Homo sapiens* waste was disposed of in open pit privies, while household wastes were discarded into open gutters. Such unsanitary conditions gave rise to typhoid fever, yellow fever, cholera, and other diseases, which substantially reduced the population at regular intervals.

By 1893, it became apparent to city leaders that accommodation of area growth would depend on their ability to keep New Orleans drained, dry, adequately supplied with water for drinking and fire protection, and provided with a sanitary sewerage system. Planning for the three systems began that year.

In 1896, the New Orleans Drainage Commission was organized to carry out a master drainage plan that had been developed for the city (Figure 108). Three years later, in 1899, the Sewerage and Water Board was authorized by the Louisiana Legislature to furnish, construct, operate, and maintain a water treatment and distribution system and a sanitary sewerage system for New Orleans. In 1903, the Drainage Commission was merged with the Sewerage and Water Board to consolidate drainage, water, and sewerage programs under one agency for more efficient operations. This combined organization retained the title Sewerage and Water Board and remains as such today. Once formally organized, the Sewerage and Water Board set out to fulfill its goals of providing the city with adequate drainage, sewerage collection, and drinking water. Between 1879 and 1915, \$27,500,000 was spent on the construction of water, sewerage, and drainage facilities designed to accomplish these goals.

#### **A.1.7 Stormwater**

In 1900, the Sewerage and Water Board began work on open drainage canals and pumps that could remove five inches of rain in a five-hour period from the community's mid-city bowl. By World War I, new technologies allowed settlement on terrain that decades earlier had formed part of the city's back swamp. The invention of Robert Baldwin Wood's screw pumps in 1913 allowed the draining of thousands of acres of formerly undevelopable swamp land (Romagosa, 2010). In 1899, 13,000 acres of swamps had been drained. By 1925 that number had grown to 40,000. With the availability of new land for residential development, building permits skyrocketed. While 55 building permits were issued in 1918, by 1923 that number grew to 3049. Wood's pumps facilitated the creation of new suburbs with restrictive covenants, which in turn advanced segregation of the city. The city and its suburbs must collect and pump out an average 60 inches of rain that falls annually into what is often described as a giant bowl. All development within the basin adds to surface runoff and is subject to periodic flooding from storms that exceed the pumping systems short term capacity. The city and its occupants are situated in harm's way. With this general pattern, water flows away from money, away from the property of those who can afford to live in less flood-prone areas and those with the influence to secure adequate financed water-removal services.

Although built in three phases, the system successfully transformed a sizeable area from swamp land into developable land by lowering the water table. The system enabled rapid urbanization in the bottom of the bowl and toward the lakefront. However, the improvements, coupled with increased runoff from development in the bowl and subsidence which offset pumping capacity, proved to be inadequate to prevent periodic flooding by the time they were completed in 1928.

A vastly improved barrier lined the river by the early twentieth century and withstood several tests. Water rose more than 20 feet in New Orleans in 1907, 1910, and 1914, but the levees held. In 1922, crevasses spilled water onto rural farmland upstream but a relief outlet below the city eased the pressure on the municipal levee. During the spring of 1927, the most devastating floods in Mississippi Valley history broke through levees upstream and forced thousands to flee their homes. Only

dynamiting a break in the levee (known as the Caernavon Crevasse) thirteen miles below the city prevented New Orleans from being flooded (Barry, 1998). This decision, taken by the city's elected officials and elites, may have spared the city but resulted in the inundation of rural (and poorer) areas of St. Bernard and Plaquemine parishes, forcing the evacuation of over 10,000 people and severely damaged small communities and agricultural lands. No event in the city's history has been more significant in shaping people's perception of the city.

On Good Friday, 1927, fourteen inches of rain fell in New Orleans and the problem of internal flooding became all too obvious. The city's pumping system was overwhelmed and caused flooding, particularly in the bottom of the bowl and in low areas beyond the natural levees along Bayou St. John. More rains further aggravated the system. While the levees protected a majority of the city, major flooding in the bottom of the bowl, the back-swamp neighborhoods, and even in better drained neighborhoods created a call for further improvements. The Great Flood of 1927 was the greatest natural disaster in American history.

In 1922, the state authorized the Orleans Levee Board to build a 5.5-mile seawall between the mouth of the New Basin Canal and the Industrial Canal. After the seawall was built, the levee board pumped sediment from Lake Pontchartrain into the area landward of the new barrier, creating extensive new land for development. Completed in 1934, the new made land was utilized for high end residential development and recreational uses. Adjacent Jefferson Parish constructed a six-foot-high protection levee in 1926. These improvements encouraged residential expansion into the former wetlands.

Lake Pontchartrain is a permanent barrier to New Orleans' growth to the north. Vast wetlands inhibited expansion to the east and west before 1940. By the 1930s, drainage and landfill efforts had reclaimed wetland between the city and the lake. In the postwar years, similar campaigns dewatered marshlands for housing development eastward from the city and westward into Jefferson Parish.

No serious hurricane had buffeted the city since 1915, but a storm in 1947 demonstrated the vulnerability of new lakefront suburbs. A hurricane packing 112 miles per hour winds tracked across Lake Pontchartrain, pushing Gulf waters into the Lake and then shoving it up against what proved to be a hapless shoreline protection system. Waves topped the seawall in Orleans Parish and inundated nearly 9 square miles with water 2 feet deep covering a quarter of that area. Resting on highly compressible subsoils, the Jefferson Parish levees had subsided in the two decades since their construction and provided less protection than the Orleans Parish seawall. The storm-propelled waves inundated over 30 square miles of Jefferson Parish. Obviously, the lakefront barrier was not up to the task. With the assistance from the Corps of Engineers, Parish officials gradually raised the levees to about 14 feet by the 1970s.

While this barrier prevented a repeat of the flooding produced by the 1947 storm, subsequent hurricane-driven water still found breaches in the levee system. Hurricane Betsy bore down on the city in 1965 after pummeling the Louisiana coast with winds up to 160 miles per hour. Winds raced through the city at 100 miles per hour. The worst flooding occurred when the tidal surge breached the west levee of the Inner Harbor Navigation Canal (formerly the Industrial Canal). Water in low-lying areas reached 8 feet. More than seven thousand homes suffered damages along with more than three hundred industries. The Corps of Engineers reported that waves overtopped the lakefront seawall, but a secondary levee built after 1947 prevented inland damages. Likewise, the levee prevented any noteworthy damages in lakefront areas of Jefferson Parish. Hurricane Camille was a legendary Gulf Coast storm whose most intense winds passed well east of New Orleans in 1969. While the hurricane devastated Mississippi's coastline, New Orleans' levee system successfully protected most of the city from flooding. Nonetheless, a levee section along the Inner Harbor Navigation Canal failed due to wave-powered scouring at its base, and water poured into residential areas. The original 1895 plan called for draining 5402.15 hectares (13,349 acres), but by 1950 over 19,829.59 hectares (49,000 acres) lay within the system domain, and by 1983 the area had expanded to over 36,421.74 hectares (90,000 acres).



Over time, planners and engineers sought to force a shift from structural protection to a system wherein planning and construction codes inhibit inappropriate development in flood-prone areas and those who chose to live in high-risk zones pay the cost of protection through insurance premiums. Although flood insurance subscriptions in Louisiana were well above the national average by the early 1970s, neither New Orleans nor suburban Jefferson Parish fully employed the land-use controls necessary to make the program effective. Much of the metropolitan area is within the 100-year floodplain defined by the National Flood Insurance Program (NFIP).

The NFIP was founded in 1968. Before 1950, a property owner obtained flood insurance through their standard homeowner's policy. The high relationship of losses by holders of flood policies caused many insurance companies to begin excluding flood coverage from standard insurance policies. By the 1960s the private sector provided flood insurance became completely unprofitable. The burden of providing insurance as an alternative to disaster relief was assumed by the federal government. Federal insurance rates were below market rates and thus subsidized by the federal government. In addition, the victims of floods often received disaster relief payments and insurance payouts. Flood insurance is only required to obtain a mortgage, thus making it somewhat more likely that flood-prone areas will be occupied by seniors who have paid off their mortgages, investors who have acquired property for rental income, or the poor who cannot afford mortgages. Flood insurance payments only cover losses for the owner of the property and claims are subject to caps, further increasing the likelihood that properties will be occupied by renters. Flood-prone properties are more likely to be offered for rent because of the owner's increased risks and costs. Such properties are often offered for rent at a discount which attracts lower income groups, seniors, and the infirmed. Critics argue that the government's subsidized insurance plan encourages building and rebuilding in vulnerable coastal areas and floodplains (Hanscom, 2014). The National Flood Insurance Program is yet another example of a management disturbance with unintended consequences.

Given the topographic situation and the early twentieth-century approach, structural flood abatement remained essential. Frequent flooding left Federal

Emergency Management Agency (FEMA) administrators exasperated with the frequency of repetitive payments for communities along the floodplain of the Mississippi (Morris, 2012).

In the spring of 1978, a freak storm dumped more than nine inches of rain in New Orleans in less than eight hours. This storm vastly exceeded the drainage system's capabilities for expelling rainfall and became the standard by which future events were measured. While streets turned into rivers throughout the city, the Broadmoor section (the bottom of the city's "bowl" which was first drained earlier in the century by the Wood Screw pump) was particularly hard hit. Much of it is below sea level, and the drainage system funnels runoff from a huge crescent-shaped area along the river into this low area, where it is then pumped out of the "bowl." Another flood in 1982 damaged 1400 structures, and a third flood in 1983 damaged 1775 structures.

Although the city began participating in the NFIP in 1975, effective compliance was not prompt (Figure 109). New Orleans revised its 1950s-construction standard that called for slabs to be a foot above the natural ground to one that required them to be 18 inches above the highest point of the curb adjacent to the property. The lowest support beams for houses raised above ground level on piers had to be 24 inches above the curb rather than 24 inches above natural ground. City building inspectors began making systematic inspections for compliance with flood protection standards in the 1990s. Some inspectors rejected numerous permit applications in the late 1990s, due either to insufficient floor elevations or inadequate site improvements to minimize flooding. These steps of course had little impact in older districts, which were densely built up and still had to rely on structural measures such as pumps and canals.

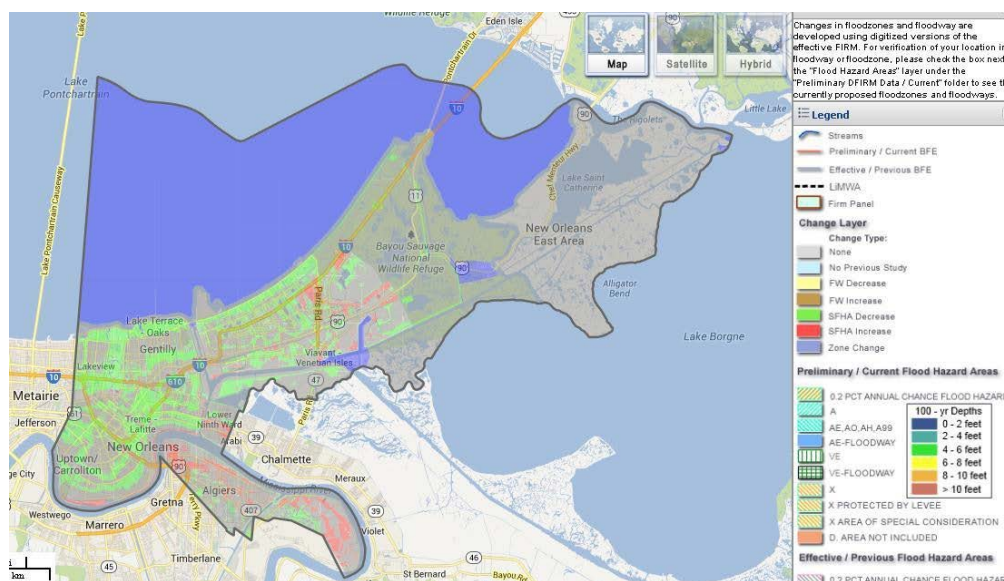


Figure 109: National Flood Insurance Map of New Orleans 2016

Tropical storm Allison stalled over south Louisiana in June 2001 and released more than 20 inches of rain in some locations. Although precipitation totals were substantial, the fact that moderate rains fell over a four-day period allowed the drainage system to keep pace with the deluge. There was some street flooding, but there was virtually no reported residential damage in New Orleans. This test of the drainage system convinced some that improvements were finally meeting the citizen's needs.

In September, 2002, Isidore, a hurricane down-graded to tropical storm status, revealed some lingering weakness in the system. Part of New Orleans received as much as 23 inches of rain in 8 hours as the storm moved inland from the Gulf of Mexico. As much as 4 inches fell in one hour and overwhelmed the expanded and improved drainage system. Major streets, including South Claiborne Avenue which passes through Broadmoor, became impassable, and even the central business district suffered temporary street flooding. The most disturbing revelation was that high waters closed Interstate 10 for more than twenty-four hours. Because the Interstate is one of the few evacuation routes from the city, this failure of the drainage system received critical attention.

A second flood-prone area, the Ninth Ward, has long been a low-income section of the city and has endured chronic neglect in terms of city services. The ward's lower sections have been victimized repeatedly by flooding. Hurricane Betsy in 1965 produced serious flooding, and a winter storm in 1983 drove water from the Gulf into the Industrial Canal. When the levee board failed to close floodgates, water rose to 3 feet high in the neighborhood.

Jefferson Parish occupies territory on both banks of the Mississippi River immediately upstream from New Orleans. Urbanization in this parish was limited primarily to the narrow natural levee and the narrower-still Metairie Ridge before 1940. On the East Bank, canals, levees, and pumps built in the 1920s enabled some residential expansion into wetland areas, but these structural controls were not wholly effective. The levee along the lakefront subsided and permitted inundations in 1937 when the Corp of Engineers first opened the Bonne Carré spillway to divert Mississippi River flood-waters into Lake Pontchartrain. Following the severe 1947 hurricane, Parish officials began a major effort to improve the East Bank drainage system. Enlarged pumping capacity and strengthened lakefront barriers in place by 1952 enabled the parish's residential neighborhoods to drain more efficiently which facilitated rapid suburbanization in the second half of the twentieth century. Population soared from 53,441 in 1950 to 290,000 in 1980 – driven largely by white flight to the East Bank bedroom suburbs. Significant land subsidence (as much as 2 feet) followed drainage, lowering large portions of the parish below sea level. Consequently, all drainage requires pumps to lift water into either the Mississippi River or Lake Pontchartrain.

Each new district pushed the usable land back from the river utilizing canals and pumps to transport runoff and groundwater through ring levees into the back swamp. As on the East Bank, structural means had opened considerable territory – some 14,164 hectares (35,000 acres) – to development by 1980. Industry had occupied most of the best drained land on the west bank, leaving the more recently drained and topographically lower areas for residential use. Drainage improvements have concentrated residential areas in former wetlands, which face the greatest flood risks due to their low-lying situation.

With the founding of the National Flood Insurance Program in 1968, area developers expressed fears that flood insurance costs would halt residential expansion in Jefferson Parish, but there was exceptionally high participation in the insurance program, with more than ten thousand policyholders in 1974. That number grew to more than 61,000 in 1993. A large white majority on the East Bank (77 percent) who bore less of the flood's impact than African Americans on the West Bank rejected the proposed tax. The flood of April 1980 hit the West Bank hard, with some of the worst flooding in the greater New Orleans area. Two weeks later, an even greater rain event dropped 14 inches on the West Bank.

Building codes now call for slabs to be 18 inches above the crown of the road in front of new homes and for floors of elevated homes to be at least 18 inches above the road crown. The Parish cites the drop in all claims from 2,580 after the 1995 flood to only 61 total claims after tropical storm Allison in 2001 as measurable progress in flood prevention prompted by a federal lawsuit.

Citizens who opt not to wait for improvements can move to higher ground across the lake, and many with resources to do so have joined others relocating to the Florida parishes north shore of Lake Pontchartrain. In 1992, the City of New Orleans adopted a plan calling for restrictions on wetland development and for wetlands to be used as flood-retention basins.

Orleans Parish, on the other hand, while forced by the FEMA lawsuit to manage land use more effectively for flood protection, has petitioned the Corps of Engineers to fill more than 809 hectares (2,000 acres) of wetlands above the level of projected floods – further reducing floodwater retention capacity.

For more than two centuries, New Orleans' builders struggled to expel the soggy wetlands from within the city. Early settlers saw little value in the swamps after they had harvested the virgin cypress forests, and marshes held no value as urban real estate. In addition to expanding usable real estate, the massive drainage projects greatly reduced disease threats that had plagued the city for two centuries. Yet after more than two centuries, the drive to enlarge the drained territory was reversed. Since

about 1970, fundamental changes in public attitudes toward the environment in general and wetlands impeded the Crescent City's ever-expanding drainage program. While the City will likely never abandon its existing drainage systems or abate on-going improvement efforts, it has shelved some expansion plans. There has arisen an overwhelming urge to protect marsh and swamp in and near the city, along with programs designating wetlands as relicts of Louisiana's natural history. Recent proposals have urged the city to "live with water" and incorporate open water into the fabric of the city rather than focusing on massive efforts and flood protection and pumping. (Waggonner and Ball, 2010). Discussions are taking place now (2016) that will amend the City's Comprehensive Master Plan to incorporate such strategies.

In Louisiana, urban wetlands were distinct from their rural counterparts. Though long considered harbors of pestilence, wetlands were platted as residential and commercial real estate, and thus cartographers applied an urban imprint upon them well before the construction of drainage canals, levees, or streets. Rural wetlands, by contrast, served as locales for hunting and fishing, logging, and oil drilling. When Louisiana set aside more than 80,937 hectares (200,000 acres) of marsh habitat in the early twentieth century for environmental protection, it offered no comparable protection for urban parcels. Only in the last third of the twentieth century, with the emergence of public concern for wetlands accompanied by chemical control of mosquitoes, did city residents demand wetland creation and preservation within New Orleans. Moreover, the dewatered peaty soils within the flood barriers subsided, causing problems for suburban construction.

At the national level, public articulation of the environmental significance of wetlands emerged in the 1965 U.S. Fish and Wildlife Service Report *Wetlands in the United States*. A spate of late-1960s and early-1970s federal environmental laws began to impede wholesale wetland development in the New Orleans area. Most notably, Section 404 of the Clean Water Act (1979) prompted court decisions that expanded wetland protection from those adjacent to navigable waters to those beyond major waterways. Armed with legal tools, local wetland protection advocates stalled seemingly relentless development pressures in eastern New Orleans. In and around New Orleans after 1970, the driving motivation was to preserve a disappearing habitat,

to maintain ecological and hydrological conditions, and to protect the city from relentless coastal erosion.

In the early 1970s much of eastern Orleans Parish remained largely undeveloped marsh. Except for a few transportation routes crossing the area and some recreational facilities along the lake and bays, large privately owned marshlands lay ready for the same type of drainage and subdivision that had transformed much of the territory along the Pontchartrain lakefront. The restrictions presented by wetland regulations complicated a once straightforward technical process and increased development costs. Other complications also arose with marsh development; for example, in the early 1970s, subsidence of drained marshlands in Jefferson Parish caused gas pipeline fractures that resulted in dramatic explosions. Entire subdivisions built on recently drained peaty soils suffered fractured streets, driveways, and foundations. In some neighborhoods, where builders used pilings to stabilize homes, the residences seemed to rise above the ground when the earth around them sank. In some areas subsidence exceeded two feet, and home owners trucked in fill to raise lawns and close the gaps between foundations and the sunken ground. Obviously, this situation has an immediate and long-term negative impact on property values since such efforts are not permanent and must be periodically repeated.

New Orleans East, a major land-development with more than 8,903 hectares (20,000 acres) of marshland within New Orleans city limits, struggled but failed to obtain approval to develop its sprawling wetland and lapsed into receivership during economic hard times in 1985.

After more than two centuries of trying to exclude wetlands from their city, post- Katrina, New Orleans' citizens have now embarked on a grand crusade to reintroduce and protect swamp and marsh lands within the city. Levee and drainage system construction has enlarged the city's habitable territory, and mosquito extermination programs have dramatically reduced the threat of insect-borne disease. The fear of wetlands as harbors of disease had disappeared by the 1970s, (though recent outbreaks of Nile virus, a vector-borne disease, have raised concerns about standing

water) and few could recall the long struggle over a century ago to eliminate what has been considered a deadly habitat.

Faced with dual water hazards – riverine floods and standing water – New Orleans’ leaders embarked along two very different courses to deal with the danger of flooding in the nineteenth century. Levees became the principal device to protect the city from inundation. Given its challenges of topography, the city was initially unable to erect a sufficient barrier through combined corporate and municipal efforts. By externalizing the costs of levee construction, first to upstream agriculturalists, then to shippers tying up at the city waterfront, and ultimately the Mississippi River Commission and the Corps of Engineers, the city could secure a well-tested protection system that has kept the river out for more than a century. Its inability to contend with a high-water table left New Orleans mired, literally, in a disease- prone setting that restricted urbanization to the better-drained natural levee.

Despite a federal program to encourage land-use means to reduce flooding, New Orleans’ topography renders it utterly dependent on structural means to control internal flooding. Parishes on the north shore of Lake Pontchartrain – particularly St. Tammany – and St. Charles Parish upriver have experienced the most dramatic population increases in part because flooding is less likely than in the City of New Orleans.

Massive and shallow Lake Pontchartrain makes the city vulnerable to natural disasters. Should a Category 5 hurricane blow water over the lakefront levees, the city would be under water for months. Evacuation would face serious bottlenecks due to the limited number of escape routes across the water-logged terrain – and some of those raised highways could be over-topped by storm-driven waves. The levees constructed to protect the city from river and hurricane flooding leave it more vulnerable to flooding from intense rainfalls.

New Orleans had to make a massive investment in levees and canals, which also consumes huge accounts of urban property, and it must pay ever-increasing



prices for fuel to lift runoff and sewage out of the city. These are hardly sustainable practices, and they eat up valuable financial resources.

By 2000, thirty-eight percent of New Orleanians resided above sea level, down from about half in 1960, and over 90 percent in 1910. In 2004, category four Hurricane Ivan spared the city but did lead to the creation of a contra-flow evacuation system. On August 29, 2005, Hurricane Katrina made landfall. Multiple levee breaches turn a windy disaster into a major flood. Entire neighborhoods were inundated. Thousands of residents, mostly poor and black, were trapped with no food or water. One week after Katrina, the city's population dropped to French colonial levels. A month later, the second flood of the century in a month, Hurricane Rita, struck Louisiana, again raising gulf and lake levels in New Orleans and re-flooding the Lower Ninth Ward.

Given the destruction of Hurricane Katrina in 2005 and the resulting population loss, a national debate continues regarding the rebuilding of the city. Recommendations to abandon the low-lying areas of the city and relocate population to higher ground have met with fierce resistance from residents.

### **A 1.8 Nuisance and Industrial Development**

The economic evolution of New Orleans led to several concentrations of industrial activity within the city. Early entrepreneurs built a series of canals for drainage and connections to Lake Pontchartrain and the Mississippi River. The Old Basin or Carondelet Canal was excavated in the 1790s for drainage and navigation (shallow draft boats), between the City and Bayou St. John, which then gave access to Lake Ponchartrain. The city's terminus was at Basin Street, in-filled in the 1920s. In the second half of the nineteenth century, this corridor became a rail corridor. The construction of the Carondelet Canal and the subsequent replacement of that canal with railroad lines resulted in a concentration of industrial and warehouse land uses along Lafitte Street generally from Basin Street on the lakeside of the French Quarter to City Park Boulevard; remnants of these industrial uses remain today.

The New Basin Canal was excavated in the early 1830s in the American Sector (above Canal Street). During construction, yellow fever killed thousands of Irish immigrants working to build the canal. The New Orleans City Railroad paralleled this canal in post-Civil War era. The New Basin Canal cut through Metairie Ridge; causing flooding of the downtown area in 1871. The portion south of Metairie Ridge was filled in the 1930s, and the remainder was filled in the late 1950s when the Ponchartrian Expressway was built.

The Orleans Avenue Canal was excavated in 1833 to convey water from Bayou Metairie to Lake Pontchartrain. The Turnpike Road ran along the west side of this canal. The Upper Line/17<sup>th</sup> Street Canal along the Orleans/Jefferson Parish boundary was excavated prior to 1849 along the upper end of today's 17th Street Canal. The lower portion was excavated in 1857-58, all the way to Bucktown on the southern shore of Lake Pontchartrain. In 1853 the Jefferson & Lake Pontchartrain Railroad was built along the Upper Line Canal. The Upper Protection Canal was excavated around 1857-58 out to Lake Pontchartrain. This became the 17th Street Canal (the street was renamed Palmetto Avenue in 1894). By 1863 there were a series of east-west feeder canals serving Bayou St. John from the west side. By 1863 there were a series of North/Northeast trending drainage canals in St. Bernard Parish. Similarly, rail lines bisect the city along the Press Street/Montegut corridor.

While the location of these canals and railroads established the city's early patterns of industrial development, it was the Mississippi River and the desire to improve industrial traffic on the river that was of greater influence. To take advantage of the importance of the Mississippi River to the city's commerce, a near continuous bank of industrial land uses stretch from the upriver boundary of the city at Metairie into St. Bernard Parish downriver. By the late nineteenth century, unregulated competition among entrepreneurs along the waterfront resulted in chaotic conditions along the waterfront with the over-production of wharves, berths, and other facilities. This over-production, in turn, resulted in poor maintenance and dilapidated working conditions, and frequent labor strikes plagued the waterfront in the late 19<sup>th</sup> century (Graves, 2012).

In response to these conditions, the Louisiana legislature in 1896 created the Board of Commissioners for the Port of New Orleans, generally referred to as the Dock Board. The act gave the board all powers necessary to improve the function and advance the growth of the city's port including the power of eminent domain. The first major project of the Dock Board was the creation of the Inner Harbor Navigation Canal in 1921, a five and a half mile long, 30- foot deep canal that runs north from the Mississippi River and connects to Lake Pontchartrain. Just as the construction of railroad lines and Interstate 70 divided St. Louis into north and south sections, the Industrial Canal cut through the Ninth Ward of New Orleans, dividing the neighborhood into what is now known as the Upper and Lower Ninth Ward (Azcona, 2006).

The Lower Ninth largely did not exist at the time of construction of the Canal but experienced tremendous growth from 1910 to 1960 as the Canal became a major industrial corridor. The Industrial Canal provides evidence that the environmental risks associated with infrastructure projects can be magnified when impacting an already vulnerable population. In addition, the Industrial Canal served as a floodway and contributed to catastrophic flooding during Hurricane Betsy (1965) and Katrina (2005). Researcher Jerry Graves has argued that not only did the Industrial Canal contribute to the vulnerability of the Lower Ninth Ward, but also that this vulnerability was the reason for the initial site selection for the Canal, since residents lacked the economic means and political power to oppose the new construction, to say nothing of their ignorance of what impact it might have.

In a similar way, the Mississippi River-Gulf Outlet or MR-GO, helped funnel the flood waters of Katrina into the urbanized areas and produced massive damage in adjacent St. Bernard Parish (Azcona, 2006). The MR-GO intersects the Industrial Canal (Figure 110).



Figure 110: Map Showing Location Of The Industrial Canal And MR-GO

The use of the waterfront in New Orleans is gradually changing from industrial land uses to tourism. The opening of the Superdome in 1975 dramatically increased the tourism industry in the City of New Orleans. The Audubon Aquarium of the Americas opened on the riverfront in 1990. Reinventing the Crescent Park also on the riverfront opened in July 2015, transforming former industrial lands.

#### A.1.9 Race and Place

The ethnic geography of New Orleans was simple during the earliest years of the city (Campanella, 2008). As an isolated port with sparse population, New Orleans received little attention from the French and Spanish colonial governments. The improvement of agricultural technology led to the creation of expansive cotton and sugarcane plantations in the American South and to the institution of slavery in southern states. As an entrepôt connecting North America to Europe and beyond, New Orleans became the busiest slave market in the South.

With the sale of the Louisiana colony by France to the United States in 1803, New Orleans became one of the most important cities in the northern hemisphere, and its settlement patterns began to change. At the time of the Louisiana Purchase, locally born French-speaking Catholics (Creoles) from various Francophone/Hispanic regions and racial backgrounds were spatially intermixed throughout the city, with the enslaved near those who owned them. In 1809, over nine thousand refugees from Saint Domingue doubled New Orleans's population and reinforced its intermixed settlement pattern. The foreign-born, including Americans, were in too small a segment of the community to create ethnic enclaves until later in the nineteenth century.

After 1803, Anglo-American emigrants brought influences of American commerce, culture, and the English language, Protestantism, and a wide range of new concepts about everything from law to architecture to race relations to the New Orleans community. They gravitated to Faubourg Sainte Marie, today's Central Business District and later neighborhoods upriver. By the 1830s, many immigrants began to Anglicize their names to mask foreign or ethnic identities, and Anglo surnames numerically outnumbered French in "St. Mary" or "the American Quarter." This pattern of an Anglo community upriver city (above Canal Street) and a Creole community below Canal Street influences the city to this day.

The domestic nature of urban slavery created a checkered pattern of racial distributions in antebellum New Orleans with enslaved blacks usually living adjacent to their owners. Free people of color numerically overwhelmed the enslaved population as one went further into the Creole side of the city. As one moved upriver, the ratio reversed and slaves significantly outnumbered free people of color. Thus, the lower city developed a three-tiered, multiracial social structure with a class of marginal status and frequently mixed origin between blacks and whites. On the upper side of town, a rigid two-tiered white and black caste system evolved with the African-American ancestry often enslaved.

The Catholic, Latin ambience of the Creole quarter attracted immigrants from southern Europe, the Caribbean, and Latin America in greater proportions

than did the Anglo sector. For most of the years from 1837 to 1861, more immigrants landed in New Orleans than any other American city except New York.

In the first half of the 19<sup>th</sup> century, urbanization occurred primarily on the higher, better-drained natural levee along the Mississippi River. The areas along the river held transportation and elevation advantages but suffered environmental nuisances associated with the wharves. These areas were ideal for commerce and provided plentiful jobs for low-skilled workers. These areas held low quality housing as they were not ideal for residential development.

Areas farthest from the river in the so-called back-of-town suffered environmental risks as they were the lowest in elevation and closest to the mosquito-infested, flood-prone swamp. This area also had poor or non-existent infrastructure, and thus the poorest housing stock. Jobs in canal excavation, railroad construction, and other hard-labor jobs were plentiful, and many who worked in those jobs lived in these poorer sections of town.

The desirability of land also varied with distance from the urban core. The lack of mechanized transportation made the periphery inconvenient and cheap, particularly given the vast supply of available land. Inner-city land was convenient but scarce and thus valuable. The well-to-do therefore inhabited the inner city. The desirability of land also varied with distance from the river and the back swamp and indirectly with distance from the city center. Lands that were farthest from sources of nuisance and risk and closest to amenities and employment were most desirable and thus commanded the highest prices and best infrastructure and housing.

The middle of the natural levee near the inner-city today comprises the historic neighborhoods of the central French Quarter, the Central Business District, Lower Garden District, and the Garden District. Affluent St. Charles Avenue bisects the natural levee perfectly, equidistant from the riverfront nuisances and the back-swamp risks. As the civil war approached, these highly desirable, convenient, low-nuisance, and low-risk zones were home to the wealthiest families in the city. Surrounding them

were middle and working-class neighborhoods. Further out was a periphery of low-density village-like developments where the unestablished and the poor gravitated.

During the 1820s to the 1850s families of laborers, mostly Irish and German, settled through the semi-rural fringe. Here they found affordable housing and low-skill employment at the wharves, warehouses, and industries, and in canal, drainage, and railroad construction. These immigrants formed a cluster of greater and lesser concentrations with no intense clusters. Ethnic intermixing predominated.

After the American Civil War, emancipated people from nearby plantations doubled New Orleans's 1860 black population from 25,423 (14,484 enslaved) to 50,456 in 1870.

These newly free people, destitute and the target of racial prejudice, settled mostly in the least desirable, highest-risk areas in the back-of-town. Working-class black families later settled along the immediate riverfront, which afforded dock jobs and low-cost housing and was within walking distance of tree-lined boulevards and mansions which afforded domestic employment.

Creoles of color who were often socially and economically better off than then freedmen though far worse off than whites, generally remained in the lower city. By the late nineteenth century, accepted notions of a race-based gradient, stratified earlier in the nineteenth century into three distinct groups (black, Creole, and white) collided with ascendant Jim Crow laws (notably *Plessy v. Ferguson*, a case from New Orleans adjudicated by the US Supreme Court in 1896) and practices, resulting in a much more rigid black/white structure, with Creoles being situated on the black side, much to their dismay (this was even codified in law, with "blackness" being defined as having had a black ancestor four generations removed).

In the late nineteenth century, a second wave of immigration, this time from southern and eastern Europe, further changed the ethnic composition of the city. As streetcar networks were installed, the wealthy departed the inner city and settled in what had previously been the inconvenient semi-rural periphery. These once-poor

areas of market gardens developed as trendy streetcar suburbs, particularly in Uptown. This exodus which began as early as the 1830s to 1850s accelerated following the Civil War. It opened hundreds of large spacious townhouses for tenement housing for incoming immigrants. At the same time, jobs for the unskilled poor shifted from the periphery, where they had been in the agrarian days before the Civil War, to the urban core.

Unlike antebellum immigrants, those of the late 1800s, settled in a concentric zone immediately around the inner core. This immigrant belt offered enough advantages to make life easier for poor newcomers but suffered enough nuisances (crowding, noise, and crime) to keep rents affordable. This immigrant belt ran loosely from the lower French Quarter (Little Palermo) and Faubourg Marigny (Little Saxony) through Faubourg Tremé and the Third Ward (China town), around Dryad Street (the Jewish neighborhood), and toward the riverfront in what is now called Irish Channel. This “immigrant belt” was like the “zone of workingmen’s homes” described in Ernest W. Burgess’s concentric zone model.

Between 1893 and 1915, New Orleans installed a modern urban drainage system. Progressive Era municipal-improvement projects effectively neutralized topography as the premier factor restricting urban expansion, and the nuisances and risks long associated with swampland soon disappeared. The concurrent rise of automobiles and streetcars diminished geographical distances as the other constraint on urban expansion. New Orleans began to expand off the natural levee of the Mississippi and into the lowlands near Lake Pontchartrain. Concerns about storm surges were abated through the construction of artificially elevated land along the southern lakeshore from 1926 to 1934, a project of the Works Progress Administration. Blatantly racist deed covenants excluded black families from this new land, and the white middle-class denizens of the front-of-town leap-frogged over the black back-of-town and settled into modern low-lying suburbs such as Lakeview. The neutralization of topography and distance, along with legally sanctioned racial polarization, helped disaggregate the historically intermixed racial geography of New Orleans. Between 1960 and the 1980s, many whites departed again, this time for the recently drained suburbs of Jefferson, St. Bernard, and eastern



Orleans parishes. "Push factors" included resistance to school integration, crime rates, the decline of public schools, and urban decay; "pull factors" included better school districts, safety, suburban life-styles, less congestion, and lower costs of living.

One of the strongest factors that disaggregated New Orleans by race began as a progressive program to help the poor. In the late 1930s, the Housing Authority of New Orleans razed old neighborhoods for subsidized, legally segregated housing projects. When housing developments were integrated in the 1960s, white residents departed for affordable- living alternatives in working- class suburbs and were replaced by poor blacks. In a few years, thousands of the city's poorest and African Americans had become intensely consolidated into a dozen housing developments. "The Projects," about ten complexes scattered throughout the city, furthered the paradoxical *de facto* segregation of residential settlement patterns of black and white New Orleanians, even as they mingled in newly integrated schools, offices, and lunch counters. (Webster, 2015)

Suburban life-styles also beckoned immigrants. Central Americans and Vietnamese war refugees, who arrived in modest numbers from the 1970s on, tended to settle in distant, less expensive suburbs such as Kenner, eastern New Orleans, and the West Bank.

Again, the pattern in New Orleans parallels national trends. Immigrants to the United States now regularly gravitate toward suburbia, and once popular notions of immigrant-dominated inner cities and homogenous white suburbs are now increasingly obsolete. Suburban life-styles also attracted the black middle class. Because that group historically comprised the downtown-based Creole community, its expansion into suburban- style subdivisions tended to occur in the drained back swamp adjacent to the old downtown, Creole (eastern faubourgs, particularly the Seventh Ward). The development of Pontchartrain Park in 1955, the first suburban subdivision in New Orleans for blacks (financed largely by white philanthropists), began the movement of black middle classes to the eastern areas of the city. This transformation led in the 1970s and 1980s to the departure of many whites from

Gentilly, opening more (and better) housing stock for middle- class black families. The same was true for far eastern New Orleans, the last major suburban development in Orleans Parish. Mostly white in the 1960s and 1970s, New Orleans East quickly became mostly black in the 1980s with the oil bust and the rise of subsidized, multi-family housing. Areas west of City Park, such as Lakeview, remained mostly white.

The city of New Orleans had a white majority from the 1830s to the 1970s. The population of the city proper declined from a peak of 627,525 in 1960 to 462,269 in 2004; following Hurricane Katrina, it declined even more and now, over ten years later, has slowly returned to its pre-Katrina levels. Over two-thirds of the 2004 population was black. Wealthier whites predominated in the higher-elevation swath from the French Quarter through Uptown and in low-lying Lakeview; while middle-class African Americans, including those of Creole ancestry, predominated in the eastern half of the city, an area intersected by navigation canals connecting with the Gulf of Mexico.

Poorer African Americans settled there too but largely remained in the historical former back-of-town and immediately along the high riverfront, while the poorest blacks resided in high-density subsidized housing developments. Most immigrants lived in the suburban fringe.

A spatial analysis helps clarify the relationships among race, class, and susceptibility to hurricane damage and death. Throughout the metropolitan area which includes areas beyond the City of New Orleans, 40 percent of the total population of 988,182 resided in areas that were under water on September 8, 2005.

African Americans outnumbered whites in flooded areas by over a 2-to-1 ratio (257,375 to 121,262), even though whites outnumbered African Americans metropolis-wide (500,672 to 429,902). People of Asian and Hispanic ancestry numbered 9,240 and 11,830 among the flooded population and 25,552 and 49,342 among the total population, respectively. Thus, while the homes of one in four whites, one in four Hispanics, and one in three Asians flooded throughout the tri-parish metropolis of Orleans, Jefferson, and St.

Bernard (24, 24, and 36 percent, respectively), close to two of every three African Americans' homes (60 percent) were inundated. In sum, whites made up 51 percent of the pre-Katrina metropolitan population and 31 percent of its flood victims; blacks made up 44 and 65 percent; Asians made up 2.6 and 2.3 percent; Hispanics made up 5 and 3 percent.

Considering only New Orleans, 61 percent of the total population of 480,256 resided in areas that were flooded on September 8. Blacks outnumbered whites in that flooded area by over 3.8-to-1 ratio (220,970 to 57,469). Blacks also outnumbered whites citywide before the storm, 2.4-to-1 (323,868 to 134,012). People of Asian and Hispanic ancestry numbered 7,753 and 7,826 among the flooded population, and 10,751 and 14,663 citywide, respectively. Thus, 42 percent of whites, 52 percent of Hispanics, 68 percent of African Americans, and 72 percent of Asians saw their homes flooded in New Orleans. In sum, African Americans made up 67 percent of New Orleans's pre-Katrina population and 76 percent of its flood victims; Whites made up 28 and 20 percent; Hispanics made up 3 and 3 percent; Asians made up 2 and 3 percent.

There are similar statistics from those killed by the storm: African American victims (66 percent of storm deaths) out-numbered white victims by more than double and whites made up 31 percent, proportionate to pre-storm relative populations. Selective reporting of the above statistics can spin interpretations to favor certain narratives regarding the geographies of ethnicity and risk. Focusing on absolute figures lends support to the case for disproportionate suffering of certain groups, whereas reporting relative figures makes the victimization seem more ecumenical. Citing metropolis-level versus city-level statistics, or the number of those initially flooded versus the number persistently flooded can also buttress preconceived themes. There is no question, however, that those who were stranded in the inundated city and suffered excruciatingly long delays in rescue were overwhelmingly African American and poor, in both absolute and relative terms.

The reason for the nuanced nature of the residential flooding statistics and their openness to multiple interpretations is rooted in the complex historical

geography that explains how current demographic patterns evolved. Those reports that erroneously implied a strong positive relationship between elevation and class (and by extension race) -- in other words, higher elevations hosted wealthier residents -- reflected a failure to understand how the perceived technological neutralization of topography originally affected a negative relationship between the two: middle-class whites in the 1910s–1950s moved enthusiastically *into* the lowest-lying areas and excluded African Americans with racist deed covenants. White, prosperous Lakeview lies significantly lower than the poor, black Lower Ninth Ward. Additionally, over-simplified reports revealed a misunderstanding of the role of historical economic and environmental geographies which explain the otherwise counterintuitive settlement of working-class African Americans along some of the *highest* land in New Orleans—the riverfront. Most reports also failed to recognize that the “pull” factors of suburbia and the “push” factors of the inner city have inspired, in New Orleans as elsewhere in the nation, an out-migration among middle-class non-whites as they earlier did among middle-class whites. In seeking better lives in the suburbs, New Orleanians of all races, classes, and ethnicities, falsely secure in flood-protection and drainage technologies, moved into harm's way in proportionate numbers.

#### **A.1.10 Fragmented Metropolis**

Although the New Orleans metropolitan region did not realize the governmental fragmentation of St. Louis, it was not without its challenges. Into the mid-1800s, the French Creole population generally settled at the riverside end of the city, downriver of Canal Street, including the French Quarter, faubourgs Tremé and Marigny and some of present-day Bywater.

Most members of the English-speaking Anglo-American population, meanwhile, settled in what is now District 1, which at the time was called Faubourg St. Mary and now is the Central Business District, upriver of Canal Street. Cultural differences between the Creole and Anglo populations, each of which developed alliances with various immigrant groups, led to economic and political tensions. In

1836, New Orleans was divided itself into three semi-autonomous municipalities, each with its own council, police, schools, port, services and amenities, ostensibly united under a single mayor and a general council. These separate municipalities thus formed another kind of patch dividing the New Orleans landscape. The first municipality was comprised of the first, second, third, and fourth wards as they existed in 1836. The second municipality included the fifth and sixth wards, and the third municipality contained the seventh ward.

In 19th century New Orleans, Canal Street served as a dividing line between Anglo- and Creole-dominated municipalities. The spacious Canal Street median was jokingly referred to as a "neutral ground" between the rival ethnicities, borrowing an old colonial-era term for disputed regions between imperial claims. The term now used to describe street medians citywide.

Because Canal Street roughly separated Anglo and Creole neighborhoods, it became the logical dividing line for the two new municipalities. The mostly Creole area from Canal and Esplanade was labeled the First Municipality, while the Anglo-dominated area from Canal to Felicite (at the time New Orleans' upper edge) became the Second Municipality.

Because Esplanade Avenue divided the Creole area into two roughly equal halves, that thoroughfare became the line between the First and Third municipalities. Farthest from the urban core and downstream from its pollutants, the Third Municipality found itself on the losing end of most local maneuverings and the recipient of several unflattering nicknames: "The Old Third," "The Poor Third," "The Dirty Third," and, sarcastically, "The Glorious Third."

The municipality system wasted resources, pitted neighborhoods against each other, created great disorganization in local government, confused visitors, and wreaked havoc on the city's bond rating (Campanella, 2013). The division of the three municipalities continued until 1852 when hostilities between the Creoles and Americans subsided.

Although New Orleans never realized the proliferation of suburban municipalities as in St. Louis, some significant suburban communities did develop. Just across the 17<sup>th</sup> Street Drainage Canal in what is now unincorporated Jefferson Parish, the community of Metairie formed. The term Metairie is derived from the French word “Moitie” (one-half), and the French term “moitire” (used in the 12th century feudal days of Europe to describe a French farming relationship where a landowner would lease a portion of property to a farmer for 50% of the crops or produce grown by the tenant and no money as rent). Over 200 years ago, Louisiana’s French heritage established the practice of describing certain farms located on the land created by alluvial deposits of old Metairie Bayou near New Orleans as “Metairie.” The road which ran along side of Bayou Choupic (now Bayou St. John) was commonly referred to as Metairie Road. Over time, the development of this area greatly expanded and the entire expanded area is now known as Metairie. (*Historic Metairie*, 2016).

In 1855, the City of Kenner was founded by Minor Kenner on land that consisted of swampland. During 1915–1931 a streetcar line operated between New Orleans and Kenner. Kenner is now the sixth largest city in Louisiana.

The idea of a bridge spanning Lake Pontchartrain dates to the early 19th century and Bernard de Marigny, the founder of Mandeville. Marigny started a ferry service that continued to operate into the mid-1930s. The Pontchartrain Railroad carried travelers from New Orleans to nearby towns like Milneburg (now part of Gentilly) on the South Shore as early as 1830. It wasn’t until 1884 that the New Orleans and Northeastern Railroad successfully sent the first train across the lake to Slidell. In the 1920s, a proposal called for the creation of artificial islands in Lake Pontchartrain that would then be linked by a series of bridges. The modern Causeway started to take form in 1948. Finally funded by the Louisiana Legislature, the Pontchartrain Causeway opened in 1969. With the integration of public schools in 1971 and increasing white flight from the city, the Pontchartrain Causeway made it possible for white residents to leave New Orleans while maintaining employment in the city.

Just across the Mississippi from the French Quarter, Gretna was settled in 1836, known originally as Mechanicsham, growing with a railway station on the Mississippi River and a ferry across the River to New Orleans. Gretna was incorporated in 1913. Although Metairie, Gretna, and the north shore communities of Lake Pontchartrain offer alternative housing locations for residents, New Orleans lacks the complexity created by the multiple jurisdictions of St. Louis.

#### **A. 1.11 De-industrialization**

In the mid-nineteenth century, the Port of New Orleans was the second busiest in the world, ranking only behind New York City. By 1900, New Orleans dropped from the fourth busiest port in the world to twelfth. During the 1960s and 1970s the port further declined due to containerization of cargo and deindustrialization of ports. The less labor-intensive containerized operations meant less unionized longshoreman, employment largely for African- Americans, and further exasperated the economic divide between the races. In 2006, New Orleans carried less than one percent of the United States container traffic. Houston, Miami, Savannah, and Gulfport, Mississippi, now carry more. Although New Orleans remains an important port with the vast Port of the South (comprised of five ports along the Mississippi River) it is only a shadow of what it once was (Mah, 2014). Former industrial lands on the waterfront are increasingly being converted to tourism-oriented land uses, such as the Aquarium of the Americas and open space such as the Crescent Park. As proximity to industrial lands is one indicator of land vacancy, these shifting land uses present the opportunity for the repopulation of some vacant lands.

Some large ship building operations remained, notably the Avondale shipyard, but this work tended to provide employment for a relatively small number of workers, mostly skilled labor. Furthermore, it became more cost efficient to build ships in other places along the Gulf Coast. The aerospace manufacturing industry, located mainly in the eastern part of New Orleans, declined in activity with the slowing of the space race after the 1970s. By 2000, manufacturing accounted for only 5% of local employment.

The oil bust of the 1980s further damaged the city's economy as much of the industry relocated to the more favorable business climates of Houston and to other Louisiana cities (notably Lafayette).

With the decline of the maritime port and the loss of much of its modest manufacturing sector, New Orleans has turned its focus to tourism and the service sector. The jobs that tourism offers, however, are typically low-income service jobs (Lewis 2003 [1976]; Gotham 2007).

The de-industrialization of New Orleans offers the potential to remove noxious land uses near residential areas as less industrial land is demanded by the market. This in turn may reduce vacant lands. The rapid development because of the creation of the Lafitte Greenway on former industrial lands provides some indication of the potential for change in this direction.

#### **A.1.12 Tax Policy**

Sales and property tax policies do not appear to be as great a driver of land use patterns in New Orleans as in the St. Louis region. New Orleans has among the highest sales tax rates in the United States, currently ranking eighth in combined local and state sales tax rates among the 50 largest cities in the United States, and sixth in terms of local sales tax alone. This high rank is understandable for a city that is largely dependent upon a tourist economy as the city shifts the tax burden to visitors rather than residents (the Tax Foundation, 2016). Although New Orleans has a combined city, parish, and state sales tax rate of 10%, adjacent Metairie (9.75%), Kenner (9.75%), Gretna (9.75%) and Northshore communities Mandeville (10.25%) and Covington (9.75%) are not materially different and do not appear to be sufficiently different to drive land use change.

At just 0.46%, Louisiana has the third lowest effective property tax rate of any state. The combined city, parish, and state property tax rate in New Orleans is 0.740%,



less than that of the North shore communities of Mandeville (0.823%) and Covington (0.823%), but more than the adjacent communities of Metairie (0.492%), Kenner (0.492%) and Gretna (0.492%). Because combined property tax rates are lower in Metairie, Kenner, and Gretna, this tax differential could provide a “pull” effect for residents to these communities.

### **A.1.13 Zoning**

The 1921 Louisiana Constitution empowered a local governmental subdivision to adopt regulations for land use, zoning and historic preservation, which authority is declared to be a public purpose; create commissions and districts to implement those regulations; review decisions of any such commission; and adopt standards for use, constructions, demolition and modification of areas and structures.

The 1921 constitution, however, contained no requirement or mention of that a city should first develop a plan. This constitutional provision for land use regulation and zoning was in response to previous haphazard zoning that took place in New Orleans and Shreveport. Land use regulations were meant for municipalities, not parishes, to separate residential, industrial and commercial land uses. Prior to 1918, New Orleans had passed several hundred "spot" or "piecemeal" zoning ordinances governing construction of buildings or operation of businesses in certain blocks, streets or areas. By the 1920s, the result was a confusing, sometimes contradictory assortment of regulations, inconsistently enforced. In response to this confusion and to a "plan movement" developing nationwide, the New Orleans Commission Council in 1923 established the City Planning and Zoning Commission to act in an advisory role to the Council on planning and zoning matters.

In 1926, the United State government passed the Standard State Zoning Enabling Act (SSEA), which “empowered municipal governments to regulate buildings and structures, open spaces, density of population, and location and use of buildings, and land for trade, industry, residence, or other purposes.” When the

Louisiana state legislature adopted the SZEAL in 1926, they did not include any clause offering freedom to appoint an existing planning commission as a zoning commission. Nor did the Louisiana law require that municipal governments hold public hearings and receive reports and recommendations from a zoning commission before deciding. Municipal government bodies could proceed with zoning however they saw fit and without suggestions from any sort of board or commission. Thus, zoning occurred without any planning and at the decision of the political bodies in charge. In 1928, the Louisiana state legislature adopted Act 234, which granted authority to police juries in each parish to regulate subdivisions and layouts of streets and parks. Again, there was no requirement or mention of planning before deciding on regulations.

Following the passage of the Standard State Zoning Enabling Act, the City of New Orleans hired the St. Louis firm of Harland Bartholomew and Associates to prepare a complete city planning survey, including plans for a comprehensive zone ordinance. The ordinance was approved in June, 1929. In another parallel between the two cities, Harland Bartholomew also prepared the first comprehensive plan for St. Louis between 1916 and 1920.

New Orleans was the first city to pass an ordinance creating a historic district when an amendment to the Louisiana Constitution of 1921 laid the groundwork for the creation of the Vieux Carré Commission. This amendment specifically addressed the preservation of the traditional architecture in New Orleans' Vieux Carré, or French Quarter, and enabled the creation of a municipal body to safeguard the structures bounded by Iberville Street, Esplanade Avenue, North Rampart Street and the Mississippi River.

In 1925 the Commission Council of New Orleans established the first Vieux Carré Commission. This first commission faltered, however, because the agency was merely advisory in function. The successful 1936 legislation derived from the efforts of a small group of determined activists during this period who insured the continuing preservation of the only intact Spanish and French Colonial settlement remaining in this country.

In 1936 the Louisiana Constitution was amended to authorize the New Orleans City Council to create the Commission and to define its composition, purpose, and area of jurisdiction. In 1946, the Louisiana state legislature adopted the City Planning Enabling Act (CPEA) passed by the U.S. government in 1928. The CPEA describes the duty of municipal planning commissions “to make and adopt a master plan for the physical development of the municipality...” Like the SZEa, the CPEA did not clearly define master plan: “by this expression is meant a comprehensive scheme of development of the general fundamentals of a municipal plan. An express definition has not been thought desirable or necessary.”

At this point in time (1946), the purposes of land use planning and zoning were to combat the negative impacts of inner city urban life. The CPEA did not extend to areas outside of cities and municipal territories. Both the SZEa and the CPEA put the burden on states to define “comprehensive plan” and to enforce it through state legislation. Again, Louisiana municipalities could adopt land use and zoning regulations, but no comprehensive plan or master plan was ever referenced or defined in state legislation. Thus, zoning happened without planning.

A third City of New Orleans zoning ordinance was established in 1970. In 1976, the New Orleans Historic District Landmarks Commission was established. The creation of the Central Business District Historic District Landmarks Commission followed in 1978. Subsequently historic districts were established for Algiers Point, Bywater, Canal Street, Esplanade Ridge, Faubourg Marigny, Garden District, Holy Cross, Irish Channel, Lafayette Square, Lower Garden District, Poydras Place, St. Charles, Tremé, and the Warehouse District. The list of historic neighborhoods has since increased to 17 (2016).

Over the years, the 1970 Zoning Ordinance was amended hundreds of times before being replaced in 2015. After four years of work in May, 2015, the City of New Orleans passed a new comprehensive zoning ordinance (CSO), with provisions enumerated for additions and changes (Figure 111). Discussion is now (2016) happening concerning revisions and changes to the CZO to address issues such as storm water management, open space equity, and more efficient allocations of

resources for public uses. This series of zoning maps over time have further defined a series of habitat patches in the community as planners seek to lock land uses in place.

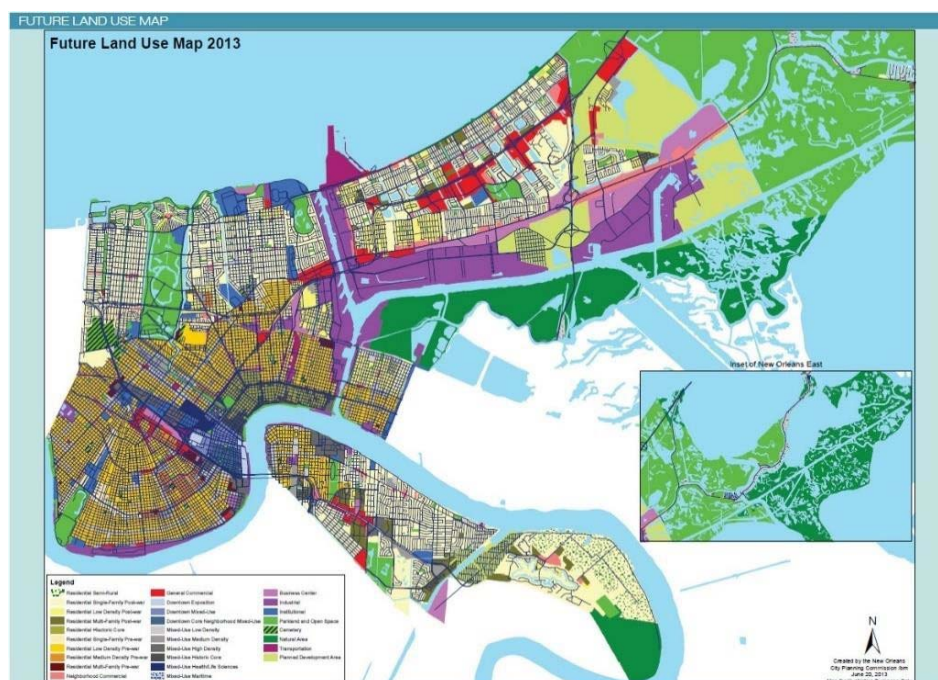


Figure 111: New Orleans Future Land Use 2013

## **Appendix B: The Environmental History of St. Louis**

### **B.1 Environmental Setting**

As in New Orleans, a review of the environmental history of the St. Louis region requires the consideration of complex interactions between *Homo sapiens* and natural forces and assessments of the health of the environment, the sustainability of urban ecological systems, and the impact of environmental transformation on issues of equity and environmental justice. This review illustrates the impact of 251 years of disturbance patch dynamics on the health of the city. As in New Orleans, much of the *Homo sapiens* manipulation of the landscape was intended to make nature predictable or at least to insulate *Homo sapiens* from the social and economic costs of its unpredictability. This goal was particularly important to those tasked with making long-term infrastructure investments in the city. But as the repeated failures of the levees of New Orleans suggest, making nature predictable is impossible, particularly over a long period.

The present environment of the St. Louis region was shaped by thousands, if not millions, of years of natural processes including geologic, hydrologic, climatologic, biologic, and these interact in complex ways. One may view the environmental history of the region as a zone of encounters between contrasting natural regions. First, on the west side is an area, containing the city and county of St. Louis, of the uplifting Ozark dome bearing an array of metals, and on the east, is the Illinois basin, a source of carbon fuels. The two contrasting resources converge at St. Louis. Second, while part of the St. Louis region is a low-relief plain, a result of glaciation, the other is part of a hill country of narrow ridges and deep valleys that escaped modification through glaciation. Third, on its west sides St. Louis extends to the great grassland biome of the American Midwest and on the east into a deciduous forest biome. Influenced by the

biological processes of both, the St. Louis metropolitan region is an intricate mosaic of bio-geographical patches and a region rich in biological diversity.

*Homo sapiens* have adapted the St. Louis region to their needs in many ways. Aggregated mineral resources reshaped the topography, altered the air, changed water quantities, qualities, and distributions, and severely affected the soils, plants, and animals of the urban region. Tectonically, the St. Louis region lies between the Ozark uplift to the south- southwest where rock strata have domed upward and the Illinois basin to the east where rock strata have subsided. The more resistant formations are hilly belts or eroded escarpments, and the most prominent of these is the Burlington escarpment, primarily of limestone. The escarpment swings from southern Warren County, Missouri, through far western St. Louis County and into eastern Jefferson and Ste. Genevieve counties. In contrast, less resistant formations of soluble limestone strata form the low-relief surface of St. Louis city, comprised of lower-relief hills or even plains.

The ancient rocks of the Ozarks to the south-southwest are a primary source of metals including lead, iron, nickel, zinc, copper, cobalt, and silver. These metals provided the basis for the early and sustained growth of a prominent metal industry at St. Louis, beginning with lead in the early years of the nineteenth century and culminating in massive iron and steel works in the mid-twentieth century. St. Louis is the only metropolitan area in the United States that refines five primary metals (lead, zinc, copper, magnesium, and imported aluminum) in addition to maintaining iron and steel industries. The older rocks of the Ozarks also provide barite used in the petroleum and chemical industries. The region also provided granite, used for paving the St. Louis wharf and downtown streets in the nineteenth century as well as stone for buildings; silica sand for glassmaking for St. Louis' large brewing industry, and, salt from the Meramec River and the Saline south of Ste. Genevieve.

Though the French discovered and mined exposed coal in the bluffs along the Missouri well before 1800, it is the large Illinois basin that has long been the primary energy source for St. Louis. Train and barge-loads of coal have arrived at St. Louis daily for more than one hundred years. Gasification of coals, common in the early years of the

twentieth century, also produced polychlorinated biphenyls, or PCBs, and those have migrated into the soils of St. Louis.

### **B.1.1 Geology**

Physically St. Louis may be thought of as a transformation and reconstitution of natural limestone into streets and buildings. Huge quarries, from which limestone has been withdrawn, are found throughout the St. Louis region. The older ones in the heart of the city were used as public dumping grounds for waste. Imbedded with the limestone and dolomites are shales and clays of mineable quality, including fire and pottery clays. The highest area of the city, known as the Hill was higher than the surrounding solution-lowered limestone terrain and was occupied by Italians and other immigrants who found employment in the mines and clay-based factories of the neighborhood.

The carbonate rocks are soluble to different degrees. Over the quarter-billion years that they have been dissolving, they have produced a surface landscape of sinkholes and solution basins with a diminished number of streams and subsurface landscape of caves, solution- widened joints and cracks, and enhanced groundwater movement.

The largest limestone sinkhole in the area, better termed a solution basin, was occupied by the 100-acre marsh and shallow Chouteau's Pond, whose water level was maintained constant by an outlet dam constructed in the first years of the city's existence. Chouteau's Pond received much of the surface runoff and subsurface drainage of the central city, so that as the city expanded and surrounded the pond, it became inexorably polluted and useless except as a wastewater sump. When railroads came to St. Louis in the 1850s, the fouled pond was drained, creating a large tract of land in the heart of the city suitable for hectares of railroad yards associated with industries and warehousing and a huge train station. The former Chouteau's Pond and

the valley of Mill Creek that led into it from the west are now a wide transportation and industrial corridor, dividing St. Louis into “north” and “south” to this day.

In north St. Louis County, Spanish Lake is a well-known example of a water-filled plugged sinkhole, once common throughout St. Louis City and County. The plugged sinkhole ponds behind the early village of St. Louis supplied the villagers with waterfowl and fish. In fact, the spring water issuing from caves at the base of the Mississippi River bluffs below Jefferson Barracks still runs dark at times. Once polluted, the groundwater reservoir takes a very long time to regenerate. Current proposals to recreate Chouteau’s Pond as a centerpiece of urban renewal is one example of how an understanding of historical ecology might guide future decision making (Figure 112).



Figure 112: Lithograph of Chouteau’s Pond

Because the sinkholes were so numerous and interconnected underground by passageways, the groundwater of the city quickly became polluted. The seriousness of the groundwater problem and its geographical association with the occurrence and



spread of cholera and other diseases led to the creation in the 1850s of sewer systems, each originally organized around a naturally interconnected assemblage of sinkholes, then finally integrated into larger sewer districts. Remnants of the lake sediments remain as terraces tucked in tributary valleys behind the bluff lines of the Mississippi and Missouri rivers, well above the floods of those rivers.

The American Midwest has been subjected to accelerated wind erosion and deposition of silts, some clays, and very fine sands, commonly called dust. The surface of the St. Louis region was mantled with at least a few feet to as much as eighty feet of this wind-borne silt or loess during the millennia of the retreat of the Wisconsin glacier. Loess, in a natural state with vegetative cover, tends to resist wind and water erosion. However, once cut into by running water or plowing, it erodes rapidly and in a distinctive vertical fashion, producing deep gullies and canyons in the bluff lands. Loess is easily moved about by modern earth-moving equipment and has been leveled off in numerous places for development. Indeed, the topographic bluff lands in the St. Louis region has been more reconfigured by loess removal, both natural and *Homo sapiens*, than by any other process. A visual inspection of a slope map of the St. Louis region suggests that the site of the city is far flatter than the surrounding landscape of narrow ridges and deep valleys, no doubt the product of centuries of shaping by *Homo sapiens* occupation.

### **B.1.2 Hydrology**

During the past thousand years of post-glacial history, the Mississippi and Missouri rivers continue to be the most dynamic natural agents of change in the surface environment of the St. Louis region. The steeper Missouri River enables it to move coarse sediment, most of which is gravel at the channel's bottom. The floodplain areas along the Missouri, away from the channel proper, had a few natural lakes or perennial wetlands above St. Charles. In the St. Louis region, they included, in historical times, Creve Coeur Lake in St. Louis County, Marais Croche, and Marais Temps Clair in St. Charles County.

The Mississippi River above the Missouri River naturally has a gradient, half that of the Missouri, but it maintains sufficient velocity to keep a coarse bed load of sand in motion. Therefore, the Mississippi River's channel does not meander as much as the Missouri River's channel. The Mississippi River carries much less suspended load since the loess region it drains is better vegetated and yields less silt. The flood plain is wetter than the Missouri too. The lower Illinois River naturally has an incredibly low gradient, which is not much different from lake water. Below the junction of the three rivers, the united Mississippi River combines features of all three rivers above it.

As in New Orleans, landscapes which were believed to produce disease were not considered desirable for settlement. The European-Americans associated the lakes and natural wetlands of the great river bottom with summer and autumnal fevers, especially malaria, and they categorically considered these areas unhealthful for settlement. The period before the twentieth century is thus a story of persistent efforts to drain the river bottoms of standing waters and wetlands because of the fear of malaria.

In the twentieth century, *Homo sapiens* thoroughly changed the nature of the three large rivers and their alluvial bottoms in the St. Louis region through a variety of engineering works. As in New Orleans, high earthen levees and concrete floodwalls line the channels to protect adjacent floodplains from overbank flooding, but these will not protect against unusually high floodwaters.

Different methods of bank stabilization insured that the large rivers no longer migrate laterally across the flood plain. The city made great efforts in the nineteenth century to insure a constant flow of water in front of the downtown harbor. After twenty years of sustained effort, the city eliminated two islands situated in the river by attaching them to the shore, one on the Illinois side and the other on the Missouri, to give unobstructed access to seven miles of waterfront.

Coupled with ever-increasing expectations of government public assistance when flooding occurs, a sense of security encouraged more economic investment on

the flood plains. In East St. Louis, the process began in the late nineteenth century. In places, flood plains have been used as primary dumping grounds for the wastes and derelict materials (some of them toxic) of a changing urban region. Impermeable surfaces cause the surface runoff from precipitation to move more rapidly into streams, some with concrete channels like the River des Peres, and into storm sewers, which are really the pre-urban rivers and creeks put underground and out of sight.

### **B.1.3 Vegetation**

Following the Last Glacial Maximum (Ice Age), the spruce-fir forest gave way to grasslands and deciduous trees. The Ozarks, including its reaches into the St. Louis metropolitan region, has been identified as a region rich in relict species cut off from their major populations to the north, south, east, and west. The St. Louis region's biological diversity may thus be interpreted as a long-standing zone of tension between true grassland and forest biomes. At the time of the founding of the city, the site of St. Louis was a mixture of grassland (approximately sixty percent of the area) and forest or woodland. Both climate and fire produced and maintained the prairie peninsula of the St. Louis region, the eastward extension of grassland into the middle Mississippi valley and beyond. The so-called "forests" of the Ozarks were naturally more open, or savanna-like, from fire, with abundant grasses amid the trees. They would be better referred to as "open forests" or "woodlands." The French in pre-American Missouri referred to the tree-covered hills as *bois*, not *forte*. These woodlands are now *Homo sapiens*-managed forests. River bottoms also served St. Louis well as sources of lumber, but more importantly, they were areas where beaver and otter lived during the pre- American years, before over-hunting due to economic demand caused their near extinction from the region. Each wave of change, whether long or short, ended with both subtractions and additions to the long list of components of the St. Louis environment.

The "American Bottom" is usually considered to be the broad expanse of floodplain on the Illinois side of the Mississippi River, bounded on the east by the bluffs stretching from Alton on the north to just south of the mouth of the Kaskaskia

River near Chester, approximately 160 kilometers in length (Figure 113). This “Northern Bottoms Expanse” is primarily the result of the confluence of the Missouri and Mississippi rivers, especially the scouring action of the post-glacial melt-waters that flooded these river basins. These various fluvial features formed an interconnected “inland waterway” beyond the eastern banks of Mississippi. They also provided a superb resource base of fish, waterfowl, and aquatic plants. Periodic flooding of the region also deposited fertile soils across the ridge and swale terrain of the American Bottom. Most of the streams, lakes, and marshes that provided an “inland waterways” connecting large areas of the bottomlands have now been drained.

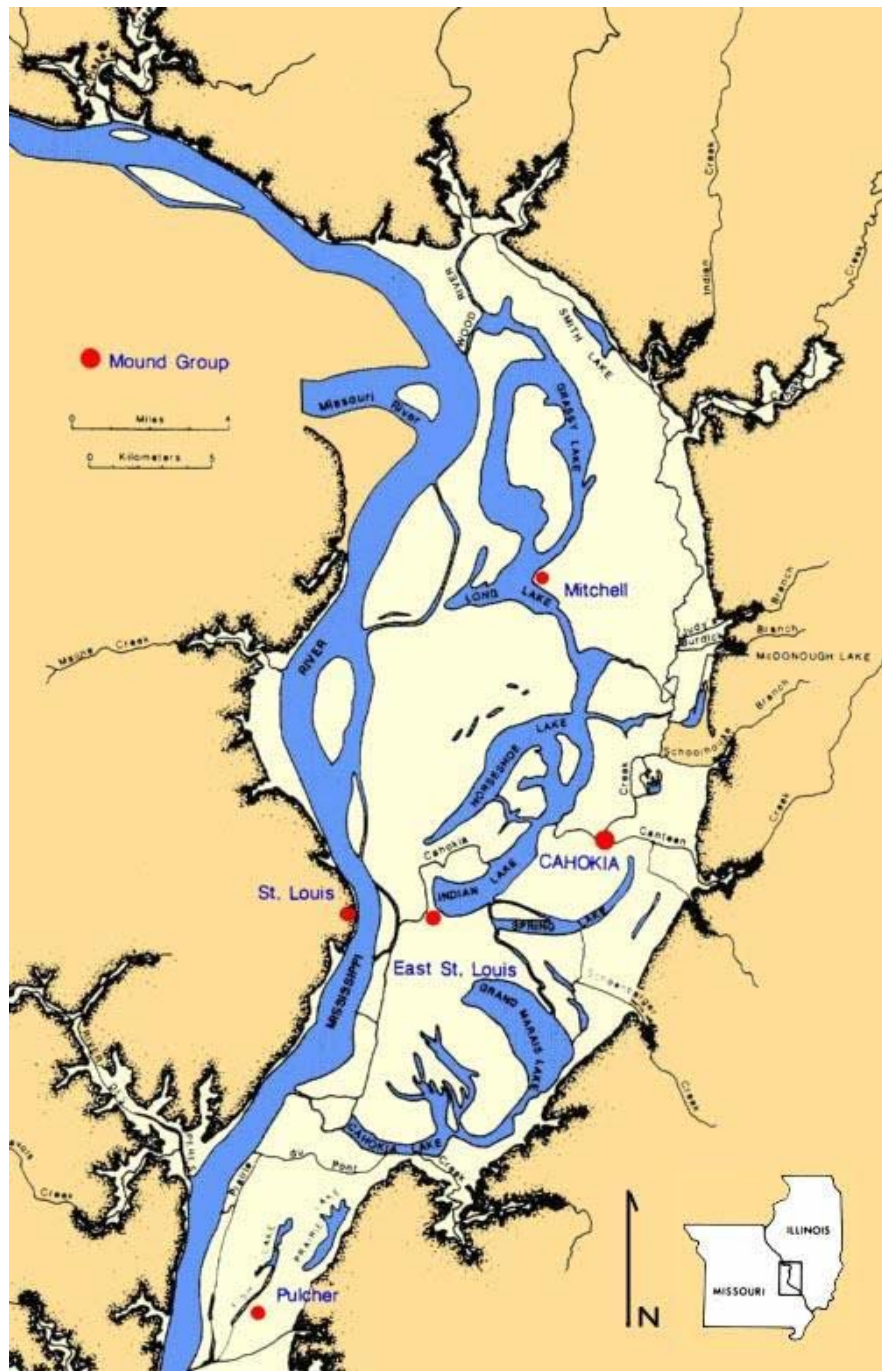


Figure 113: The American Bottom

#### **B.1.4 Native People**

Environmental changes may have contributed to the decline of the great Native American civilization of Cahokia. In addition, similar rainy summer conditions may have increased erosion in the Missouri drainage, leading to increased sediment in the Mississippi River and producing a shallower, wider channel more subject to flooding and possibly to the development of heightened water tables in the local area.

Prehistoric flooding would not have been as common as in modern times, as there would have been proportionally less runoff due to the absence of massive agricultural fields and paved urban locations. Bald cypress (*Taxodium disticum*), for example, was common in the early Mississippian phase at Cahokia but now are absent from this area. Ultimately the Cahokia civilization may have collapsed under its own weight. Its sister centers in what is now St. Louis, where twenty-six mounds once stood (thus the nickname “Mound City”) and East St. Louis, where possibly forty-five mounds were located, were destroyed in the 1800s, thereby prohibiting a contemporary understanding of this civilization.

#### **B.1.5 European Settlement**

In 1763, the French Governor of Louisiana Jean Jacques D’Abbadie granted New Orleans-based merchant Gilbert Maxent exclusive rights to the fur trade along the Missouri and upper Mississippi Rivers, and that summer a party traveled north to establish a permanent base for the firm’s operations. As the founders of New Orleans had done, these settlers chose an elevated spot on the west bank of the Mississippi approximately ten miles south of the mouth of the Missouri River. The original settlement consisted of three long streets of 36 French feet in length, parallel to the river bank in 300-foot intervals; perpendicular to these streets were a set of street 30 feet wide in intervals of 240 feet. Like New Orleans, a public place in the center of the settlement contained the open marketplace (Figure 114).

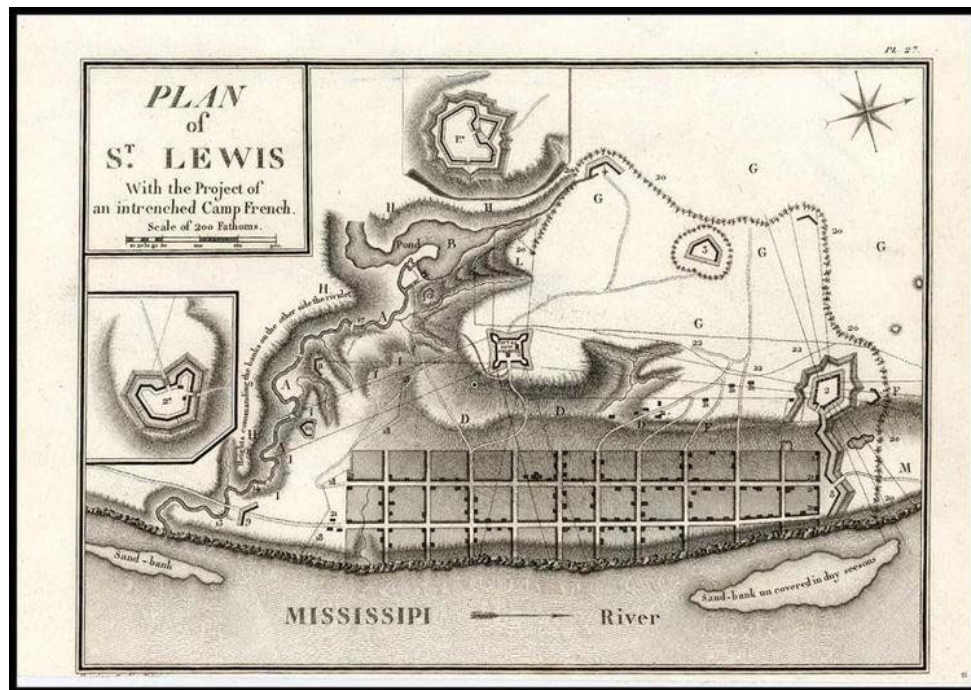


Figure 114: Collet's Map of St. Louis

### B.1.6 Water Quality

Existing features of the natural landscape and an evolving social geography conspired to deny south St. Louis residents the benefits of paved streets. Separated from the rest of the city by the Mill Creek Valley and burdened with low property values, south St. Louis was deemed an inappropriate area for the investment of public funds. Instead, city officials lavished money on the elegant boulevards of the central corridor, thereby exacerbating the relative impoverishment of the city's south side neighborhoods.

Garbage and storm water collected in the numerous sinkholes that pockmarked the city, creating a nuisance for citizens and applying constraints to further urban development. By the outbreak of the Civil War, city leaders built one of the nation's

most advanced sanitary sewer systems. Increasingly, public investment decisions were driven by the infrastructural needs of the city's most wealthy residential property owners.

A widely-held belief in the miasma theory of disease mobilized grassroots opposition to industries that generated noxious odors because they endangered public health. In adopting a quarantine approach to pollution abatement, public health officials started down a path toward zoning that would match differences in class, and by extension, ethnicity, with differences in environmental quality (Figure 115).

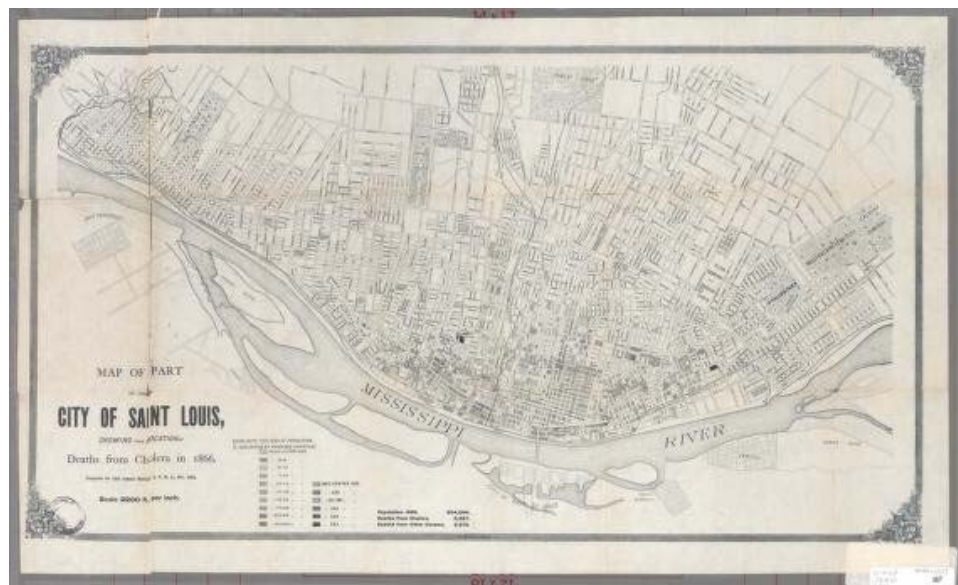


Figure 115: Map of Cholera In St. Louis 1884

### B.1.7 Stormwater

Citizens of St. Louis have agitated for clean air, pure water, and more rational management of natural resources since late 1800s. Despite concerted efforts to tame the region's waterways, the Mississippi and Missouri rivers have continued to behave independently of *Homo sapiens* will, as the Great Flood of 1993 made clear.



Within months of its founding in 1764, there was conflict between French colonists and Native Americans over who would occupy the site. In this confrontation lies the basis for an examination of views toward nature that helped to shape the growth of the eighteenth-century town. What emerges is a sense of the perceived environmental advantages St. Louis possessed both intrinsically and in comparison, to other nearby settlements. When Pierre Laclède (1729-1778) left New Orleans in the fall of 1763 to search for a good location for a trading post, he did so with goals and restrictions in mind. Laclède wanted a site that would guarantee him maximum access to the greatest number of potential consumers willing to exchange furs for his imported manufactured goods. The west bank of the Mississippi was not a matter of choice; with the end of the French and Indian War, control of territory east of the river belonged to Great Britain.

From the European perspective, the “advantages” of the site of the new settlement were numerous. Located well above the river’s flow, St. Louis, per one visitor, occupied one of the most beautiful and healthy positions along the banks of the Mississippi River. The site coupled the advantages of elevation and a limestone shore. As the flood of 1785 demonstrated, Laclède’s choice was fortuitous. The flood of that year wreaked havoc throughout the fertile lands along the Mississippi River’s shifting banks, destroying property and livestock and possibly laying the base for an outbreak of infectious disease. In contrast, St. Louis’s site remained dry, spared the depredations of the flood.

In the eyes of the many European visitors, the most notable features of the Mississippi River Valley environment were the fertility of the land, its mineral deposits, and the abundance of game. For Europeans, nature was understood, in part, as a source of commodities that could be produced or extracted for economic gain. The area surrounding St. Louis is described as an “immense prairie” where one will locate (or settle) a multitude of inhabitants.

Early descriptions of St. Louis suggest that the region’s indigenous population had used burning techniques to manipulate the environment in ways that might have

contributed to the proliferation of large animals and the ease of their hunting. Writing an early history of the city publishing, in 1843, Joseph Nicollet (1786-1843) characterized the site at the time of the founding as a plateau that “presented the aspect of a beautiful prairie, but already giving the promise of a renewed luxuriant vegetation, in consequence of the dispersion of the larger animals of chase, and the annual fires being kept out of the country, since the arrival of the whites on the Illinois side.”

A network of carefully laid out streets was soon created in St. Louis, three blocks deep, parallel to the river, and stretching nearly two miles along its banks. Low-lying swampy lands, such as those at the conjunction of rivers, tended to flood more often and retain stagnant, standing water. They posed the risks of hosting malaria-carrying mosquitoes and retaining higher chances of fecal contamination of the water supply, resulting in what contemporaries called the “bloody flux,” most likely amoebic dysentery.

Contrasting the town’s characteristics with those of New Orleans and its environs, one late eighteenth-century traveler observed that “those great vast plains and those low swamplands, such as are seen at New Orleans are not there, but instead magnificent hills and pleasant valleys.” Moreover, he noted, the residents of St. Louis enjoyed streets free of standing water where residents of New Orleans did not. By the end of the colonial period, St. Louisans of European descent had firmly established a town with recognizable French and Spanish forms and a grid work of streets oriented to and stretching along the river that remains today.

#### **B.1.8 The Era of the Steamboat**

During the first decades of the nineteenth century, the port of St. Louis rapidly became the primary point of embarkation to the American frontier. The steamboat industry, and ancillary economic enterprises such as “wooding” (the gathering of massive quantities of combustible fuel to supply the needs of steamboat boilers), had a profound effect upon both natural landforms and French colonial settlements situated on the floodplain adjacent to the Mississippi. Throughout the early and mid-nineteenth

century, the increasing demand for steamboat fuel resulted in widespread deforestation of river banks within the central Mississippi valley. Deforestation, in turn, caused the bank lines of the Mississippi River to become unstable, resulting in significant lateral channel movement. In 1854, less than four decades after their arrival in the region, steamboats were lined up side-by-side extending for more than a mile along the St. Louis riverfront.

By the last quarter of the nineteenth century, the intensive and extensive clearing and gathering of wood, primarily (but not exclusively) for steamboat fuel, had denuded both bank lines of the Mississippi River between St. Louis and the Ohio River of most stands of mature trees. Such widespread deforestation resulted in significant changes for both the Mississippi River channel depth and configuration and for many of the colonial-period settlements situated near that channel. Between 1821 and 1888 the river became increasingly wider and shallower. By 1880, the surface area of the river had increased approximately 50 percent from the area recorded during the 1821 survey. In the simple process of planning and improving their streets and roads, St. Louisans discovered that the urban landscape can never wholly erase the contours of the natural landscape beneath it. More important, they learned that the “social contours” of the land – that is, the unevenly distributed consequences of environmental conditions – were, if anything, only amplified by citizen’s efforts to control them.

Along with the surrounding common fields – the long, narrow strips of land reserved for cultivation – the shape of the common fields was but one part of a broader set of dictates by which a familiar social order would be recreated in this wilderness outpost. Chouteau’s street grid was all but unrecognizable by the time St. Louis was incorporated as an American city in 1823. As the city repeatedly expanded its boundaries over the next several decades – in 1841, 1855, 1870, and 1875 – to include ever-greater amounts of land for its growing population, street-making remained the most common and essential task facing government officials and private developers alike. An unequal geographic distribution of street improvements was based on existing conditions in the landscape and shaped the form of the city.

The Mill Creek Valley, first the site of the small east-flowing Mill Creek, was dammed in the eighteenth century to create the lake known as Chouteau's Pond (Figure 116). When the pond was drained in the 1850s, the valley soon filled with the rails of the new Pacific Railroad. Like the pond and the creek before them, the rail yards set into the ground a basic division that would be highlighted, not lessened, by further efforts to improve the city-wide landscape.

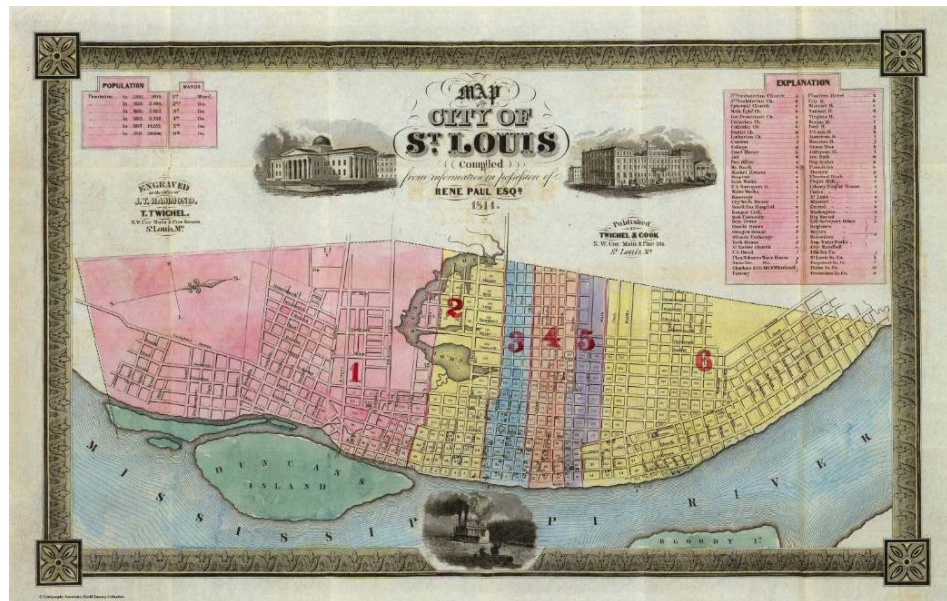


Figure 116: Renee Paul's 1844 Map of St. Louis Showing Chouteau's Pond

The historical geography of the city placed severe limits on the choices available to St. Louisans as they planned the layout of their city. The boundaries of the old common fields surrounding the original village, for instance, dictated the paths of many of the streets later laid out on the north and south sides of town, despite the problems created by their skewed and clashing grids. More striking in the long run was the effect of the Mill Creek valley, a low-lying swath of land that ran west from the Mississippi at the southern edge of the colonial village. This wide valley, first flooded for the mill, later drained and covered with the tracks of the Pacific Railroad, created a major impediment between south St. Louis and the streets of the central corridor, including downtown. Indeed, the most striking aspect of the scattered street

improvements made in south St. Louis prior to 1870 is the near-total lack of paved connections between the south side and downtown. Except for the parallel streetcar routes of Seventh Street and Carondelet Road (today's south Broadway), not far west of the Mississippi River, no improved street continued more than a few blocks south of that thoroughfare. The south side of the city was acquiring a distinct identity, as much through its increasing isolation and its unpaved streets as through the character of its growing German and Bohemian immigrant population.

Second, the very stone used on streets varied greatly from one end of the city to the other. Macadam made from stone quarried in the south side was not as durable as the rock used elsewhere in the city. Not only did the character of street vary based upon differences in materials, but the German immigrants of St. Louis who largely populated the South Side brought with them from Germany a tradition of stone building that reinforced cultural, architectural, and economic differences between the city's neighborhoods.

Without planning to do so, city officials had hardened the uneven effects of environmental conditions around the city, turning natural happenstance into political fact and creating neighborhoods that looked different from one another, literally from the ground up.

The drafting of the city charter of 1875 provided a "general plan" for the city's development. It called for the creation of long, east-west running blocks encouraging the smooth flow of traffic west from the river and indeed matched the shape of most of the blocks being laid out in the fast-growing central corridor. The plan made perfect sense in the context of improving connections from the retail, professional, governmental, and manufacturing facilities that were clustered around the courthouse and the central waterfront, to the residential and secondary commercial area that spread directly west. It did not, however, address the unimpeded isolation of the south side or match the existing north-south orientation of most of the blocks already laid out in other parts of the city. Instead, it offered a recipe for confusion, ensuring the continuation of difficult street connections between the central city and the neighborhoods to the south.

The Board of Public Improvements proved especially sensitive to the costs of improving uneven, irregular land, something that south St. Louis --- crisscrossed with limestone sinkholes and caverns – offered in generous helpings. Time and again, the board turned down petitions for street improvement from those residents with less political influence who most needed it.

Acknowledging the continued isolation of south St. Louis, the Board of Public Improvement reported in 1878 that the railroad tracks in the Mill Creek valley presented “an almost insurmountable barrier to free communication between the two parts of the city, and have seriously retarded improvements of the southern portion.” Freight railroads typically can only climb grades of 2.5-3.0 percent making the Mill Creek valley the only logical corridor for the alignment of the city’s important railroad industry to lay its tracks. This alignment of the underlying topographic condition and the needs of the railroad industry are examples of how the deep ecology of the site of St. Louis influenced the form of the city. Lindell Boulevard, the new road, which led west from the intersection of Grand Avenue and Olive Street to the still- undeveloped expanse of Forest Park at the edge of the city limits, was charted through land as unimproved and as inexpensive as any on the south side. Interest in building this corridor, in this case, apparently lay in promoting the orderly and rapid development of a region, the burgeoning West End, whose low density and ample open space already appeared to be less a matter of neglect than of choice.

The favoritism shown toward the affluent residents of the West End reflected an apparent class and ethnic bias on the part of the government. Beyond that, however, the board’s decision to improve Lindell Boulevard suggests a shift away from policies based solely on a desire to curb public expense toward those that consciously and actively promoted existing differences with the city. This view focused their attention on infrastructural improvement within a mile-wide strip that included much of the residences and workplaces of the city’s wealthiest citizens. For government officials, it simply provided further evidence of the continued good sense of tending to the better-heeled, more easily serviced central corridor.

Initially, cities built sewers to carry away storm water, but only a few, such as New York and Boston, had sewers for storm water drainage before the mid-nineteenth century; most did not have any underground drains until late in the century. Most waste water mixed with storm water in open street gutters and eventually flowed into nearby rivers or other watercourses. Because sewers did not carry waste water, integrated systems that drained large surface areas were only necessary for cities with severe drainage problems.

St. Louis, however, was a city with such inhibited natural drainage that stagnant water, coupled with frequent heavy storms, made sewer construction essential. The city sat on gently rolling prairie that rose from the west bank of the Mississippi River and was nearly surrounded by sizeable streams; its watersheds ran north toward the Missouri River, south toward the Meramec, and east toward the Mississippi.

Surface topography was deceiving. The watercourses ran downhill through the soil, but the underlying limestone strata rose and fell in ridges running roughly parallel to the Mississippi. Trenching or tunneling sewer lines through successive rocky ridges was both time-consuming and ruinously expensive.

Limestone was vulnerable to chemical weathering from rainwater laced with weak acids from carbon dioxide in the air and organic acids from the soil. Often, cave roofs had widened fissures or had collapsed, creating the depressions (sinkholes) that covered the local landscape. The city passed the first local drainage ordinance in 1841, and in 1843, a new city charter gave municipal government the power to regulate water courses and construct sewers for the first time. The St. Louis population tripled between 1840 and 1850 to nearly 80,000.

By mid-century the rise of the miasma theory gave earlier environmental concerns the sanction of medical science. Draining the St. Louis sinkholes became an urgent matter of public health, not merely one of public convenience. Coincidentally, the following summer a plague of Asiatic cholera, a bacterial disease usually spread through contaminated water, wiped out almost ten percent of the local population and further sensitized the city's residents to the link between stagnant water and sudden

death. This disease often occurs where raw sewerage contaminates water supplies. The lesson seemed clear: cholera had struck hardest in the northwest near Biddle and Ninth streets, and on July 30, 1849, the city council authorized the community's first major sewer.

The deep channel and rapid current of the Mississippi River, lying 150 feet below the highest portions of the city, were the sewer system's "great trunk." Large public sewers, like the Biddle Street Sewer, would empty into it and serve as stems from which lateral sewers would branch out. These main public sewers would lie in valleys formerly occupied by streams, or, when necessary, tunnel through ridges to tap sinkhole basins with no other means of drainage.

In 1850, the city council approved the creation of the city's first sewerage system. The system began with the Mill Creek valley, the 6,400-acre watershed dividing north and south St. Louis. The Mill Creek Sewer was built down the natural channel of the creek, and it eventually extended more than five miles west of the river to Vandeventer Avenue. In 1859, a city ordinance established routes of all public sewers, and by then, St. Louis, the nation's eighth largest city, had more than 160,000 residents.

Household and industrial wastes draining into the Mill Creek valley made it perhaps the most prolific source of miasma and malaria in the whole city, and their fumes and stench were carried back into the heart of the city by westerly winds. In 1866, a return of cholera pointed once again to miasma from waste water and plugged sinkholes and to sewer gas escaping from poorly constructed private drains. Notably, cholera deaths in 1866 did not reach 1849 levels, clear evidence that sewers were making the city healthier and a convincing argument for building them more quickly.

In 1876, voters tripled the area of St. Louis, bringing an additional forty square miles within the city limits which now extended about eight miles east of the riverfront to just beyond Forest Park. After a decade of effort, the 1.6-mile-long Arsenal Street Sewer was finally finished. The Rocky Branch and Mill Creek sewers, the city's two principal channels, were still under construction and approaching the



old limits of Grand Avenue, some thirty blocks west of the Mississippi. Every year, more *Homo sapiens* waste, was drained directly into the St. Louis system which had been designed from the beginning to be a ‘combined system’ one that drained waste water and storm water in the same pipes.

Opponents insisted in 1885 that, in a community with a storm sewer system in place, it would be foolish to build another one for waste water because of the ability of the Mississippi River to carry off and harmlessly dispose of waste.

In 1887, plans were made to extend the main public sewers into the fashionable West End. Developers continued to pipe sewage into the natural water courses, particularly the River des Peres. Although fifty-five miles of public sewers efficiently drained 263 miles of district sewers into the Mississippi, there were yet no public sewers west of Grand Avenue. A plan was developed to drain 5,342 hectares (13,200 acres) – half belonging naturally to the Mill Creek watershed and the other half to the River des Peres. The huge Mill Creek Sewer, under construction for twenty years, had nearly reached Grand Avenue, but the completed channel would never be able to carry all the flow directed to it.

By the 1880s, the water-borne nature of communicable disease was more widely accepted, and St. Louis city government finally passed an ordinance prohibiting the discharge of sewage into the River des Peres. Nevertheless, by 1894 the River des Peres was a monstrous open sewer.

At the turn of the nineteenth century, nearly six hundred thousand people lived in St. Louis. Waste water and storm water flowed together through seventy-three miles of public sewers into the Mississippi River. Four hundred twenty-three miles of district sewers covered much of the northern industrial and residential areas and the Central West End. But in south St. Louis, there were no sewers west of Grand or South of Chippewa, except in Carondelet.

The decision to host a World Fair in 1903 forced community leaders to acknowledge that they could not invite twenty million people to Forest Park without

first improving the city's infrastructure. This civic awareness in the years leading up to and following the Fair led to an emphasis on city planning that resulting in the city's first comprehensive plan in 1907.

Massive flooding of the River des Peres watershed in 1915 forced implementation of the 1907 plan. Started in 1924, the river was enclosed from the Northwest city limits through Forest Park. South of the park a sanitary sewer ran below an open channel to the Mississippi.

The creation of the metropolitan St. Louis Sewer District in 1954 finally brought city and county drainage under the same jurisdiction, but the sewage generated in the City of St. Louis and the county continued to flow untreated into the Mississippi until 1970, when Metropolitan Sewer District opened the first of two-major waste water treatment plants to serve areas draining to the Mississippi.

#### **B.1.9 Nuisance and Industrial Development as Shaper of Urban Form**

The location of nuisance businesses and industrial development also shaped the urban form of St. Louis. The dominant strategy for locating these businesses was to quarantine offensive trades, usually in areas where political opposition was weakest, property values were lowest, and residents poorest. In this way, an evolving policy for addressing nuisances constituted a crucial step in the growing fragmentation of urban space where environmental quality was linked with the social characteristics of neighborhoods.

As one of the nation's largest manufacturing cities in the early twentieth century, St. Louis generated more than its share of industrial pollution. Data from the 1880 federal census indicates that flour milling, slaughtering, machine-shop products, chewing tobacco, and malt liquor led the list of the city's manufacturing industries. In addition, the city was also a center for paint manufacturing, brickmaking, paper bag production, and iron making. These processes generated massive amounts of waste, and

by the late nineteenth century, St. Louis had already developed a reputation for its smoky skies, due in large measure to the widespread adoption of the steam engine for industrial processing that transformed St. Louis into a city of belching smokestacks.

In virtually all parts of the city, stagnant ponds served as receptacles for both domestic and industrial wastes. Some of these ponds were natural phenomena, sinkholes produced by fissures in the underground limestone; others, such as quarries, were created by *Homo sapiens* action.

While fumes from manufacturers might generate complaints based on the aggravation they caused, manufacturing establishments that handled decaying animal matter were singled out for especially harsh condemnation. Because decaying animal matter generated noxious odors, citizens who believed in the miasma theory relied on their sense of smell to detect the presence of disease-producing gases. Cholera was particularly destructive. While the disease had ravaged St. Louis twice in the past, first claiming more than 4,000 victims in 1849, and six years later, another 1,500, it was not until the spring of 1867, shortly after another vicious cholera epidemic claimed over 3,500 lives, that the city established a Board of Health with broad powers to designate and abate nuisances.

From its inception in 1868, the Board of Health considered the spatial implications of the nuisance problem. Using its regulatory authority, the board attempted to counter the geographic dispersal of nuisances through selective enforcement. That is, it sought to enforce nuisance laws strictly in some areas, thereby encouraging the concentration of such activities elsewhere. As New Orleans had done with similar land uses, city government sought to remove these nuisances from near the populous residential parts of the city and distribute them elsewhere.

Yet given that summer winds came mainly from the south, any stench produced in the southern part of the city would spread to the rest of the metropolis, thus defeating the entire purpose of isolating them in the first place. One might drive them out of the city altogether by banishing them to the eastern shore of the Mississippi River. The idea of relegating offensive trades to areas beyond the city limits had been

discussed before, but it was in defense of property values and the city's elite, that elected officials adamantly opposed locating the nuisance's district in city's western reaches.

Elected officials insisted that offensive factories find a location that did not negatively impact the residents of the city, and that was Lowell, several miles north of downtown. In the late 19<sup>th</sup> and early 20<sup>th</sup> century, industry relocated to the north of the city. With wind, predominately from the south and west, this riverfront section of the city was the most suitable for the location of offensive trades. Such a concentration would of necessity produce obnoxious odors, but at least the city could monitor the situation and prevent the most egregious abuses. Although upriver, Lowell was also closer to the confluence of the Mississippi and Missouri than the balance of the city, offering locational advantages for industry.

Lowell had become a magnet for nuisance industries over the previous two decades. A report from the early 1870s observed that the sickening and disgusting odors produced by fat melters in Lowell contaminated the atmosphere for at least a quarter of a mile in every direction and made living in the vicinity intolerable. What differentiated Lowell from Rock Spring was the social composition of the surrounding population. While Rock Spring in the 1870s was becoming surrounded by affluent suburbanites, Lowell, was described as an area that was "settled almost entirely by the poorer classes."

If the Lowell factories remained a local problem, city officials were content to turn a blind eye to pollution. But when Lowell pollution threatened to contaminate the city's supply of drinking water because of drainage into the Mississippi River, health officials were inclined to take prompt action. While passing through Lowell and Ferguson on their way to the Mississippi, two streams (Maline Creek and Harlem Creek) collected waste from the rendering plants and dairies that lined their banks. The point at which the streams entered the river lay just above the waterworks. Although not within the city limits of St. Louis, another North St. Louis County stream, Coldwater Creek, was the site of stored uranium waste from the 1940s through the

1970s. In 2014, Great Rivers Greenway was working to create the Maline Greenway which would connect Belle Fontaine County Park to the Mississippi River (Breer, 2014). In 2016, Coldwater Creek remains a major site of environmental injustice within St. Louis County.

North St. Louis residents had hoped that this popular uproar would result in the abatement of the offensive Lowell manufacturing activities. Instead they got a sewer. City official reasoned that the simplest way to prevent contamination of the city's water supply was to divert the waste stream to a point on the river below the intake valve. Construction was completed in 1885, and although the city's water supply was spared, the Lowell factories remained. As in New Orleans, the poor, the property-less, and the politically disconnected suffered the consequences.

To civic leaders and planning experts, population migration was a wholly unsatisfactory solution to the problem of industrial pollution; indeed, the movement of low income residents away from industrial areas was precisely the situation that they wished to avoid. The destabilization of residential neighborhoods because of pollution had become so troubling by the early twentieth century that it became one of the driving factors of the adoption of a city-wide zone plan.

The preservation of property values had superseded public health as the primary justification for rationalizing land use in the city. Medical experts had largely discredited the miasma theory of disease thereby minimizing the public health imperative of isolating offensive industries. Yet the persistent expansion of manufacturing into residential districts, largely a result of limited space in older parts of the city and the resulting exodus of besieged homeowners, wrought havoc on property values and denied the real estate market any long- term predictability.

In 1918 St. Louis became the second major United State city after New York to encode land use restrictions in a comprehensive zoning law. The northern riverfront, which included Lowell, and the Mill Creek Valley, which included Rock Spring, was among the major corridors designated as unrestricted in the 1918 zone plan. This

unrestricted zone could accommodate any land use and thus became a magnet for industrial and other noxious land uses.

Not surprisingly, the housing protected by zoning tended to be vested with property values well above the city average. Invariably, these neighborhoods were inhabited by the middle and upper classes, including some of the factory owners responsible for creating industrial pollution. As a means of preserving property values, zoning had nothing to offer the thousands of working-class families who rented their homes. Factory workers who, of necessity, rented dwellings close to their workplace had no claim for protection against local nuisances per the prevailing tenets of zoning theory. Indeed, zoning reduced their opportunity to escape noxious conditions by effectively barring low-income housing from cleaner, upscale neighborhoods. Clearly, when early twentieth-century planners spoke of isolating manufacturing from the population, what they meant was isolating manufacturing from better-off populations. Zoning was not so much a mechanism for separating residential, commercial, and industrial functions as it was a tool for preserving property values in selected areas of the city and maintaining the high quality of residential life for elites. But as pollution was seen less as a cause of sickness and disease and more as a threat to urban land values, civic leaders found it easier to justify land-use policies that encouraged stark inequities of environmental quality among St. Louis neighborhoods. Zoning can thus be viewed as an attempt to freeze the movement or shifting of patches and the movement of unwelcomed or nuisance uses into areas deemed worthy of protection.

Yet the most enduring legacy of the Gilded Age nuisance regulations in St. Louis lay in the attempts to create a hierarchy of place that would coincide with existing hierarchies of social status, political power, and wealth. Motivated by motives of protecting the public from disease, pollution control increasingly became a tool for protecting private property and thus distinguishing the environmental experiences of rich from poor the powerful from the powerless.

#### **B.1.10 East St. Louis**

By 1910, several industrial towns existed on the expansive floodplain east of St. Louis known as the American Bottom. As in St. Louis, residents of these floodplain communities voiced opposition to foul air and water by filing nuisance suits against polluters. The communities along the Mississippi River from south of Alton to just downstream from East St. Louis were company towns, established to serve single manufacturers.

Early industrial development of this area depended on several factors. The clustering of rail facilities at East St. Louis prompted entrepreneurs to create the National City stockyards and their associated livestock processing and packing facilities (Figure 117). The absence of legal restrictions prohibiting these practices also encouraged certain industries to locate on the American Bottom. Another extremely important factor in attracting this group of industries to the American Bottom was the availability of inexpensive coal on the Illinois side of the river.



Figure 117: National City Stockyards, East St. Louis, Illinois

In the early twentieth century, oil refiners also began to purchase sites and add to the landscape of livestock and metal processing and chemical production facilities on the East Side. Citizens held this industrial ensemble responsible for producing objectionable environmental conditions. The relatively dense, yet politically fragmented, settlement of the American Bottom created an ideal setting for pollution suits. Quite frequently, however, local statutes exempted key industries from the nuisance definition. This arrangement permitted offensive conditions to exist legally within one jurisdiction, but regulations could not confine airborne or water-carried pollutants to the territories where they were not allowed.

Struggles with the smoke issue in St. Louis had passed through the first round of reform by 1900 and underwent a second round of reform in the 1930s. The regulation of smoke in St. Louis encouraged industrial development across the river in East St. Louis. In response to flooding and the development of a levee system on the Illinois side of the river after 1903, industry was further encouraged to locate to the American Bottom during the first quarter of the century.

Several government agencies struggled for several years to resolve the pollution problems caused by the National City stockyards and packing plants, to the expense of the industry and the benefit of the citizenry. Beginning in 1904, the St. Clair Board of Supervisors declared Cahokia Creek a great menace to East St. Louis when it disgorged its contents of packing plant waste on the stream banks. The board of supervisors recommended a direct channel from the stockyards to the Mississippi River that would detour around East St. Louis and eliminate the offensive conditions. In 1929, Illinois created a second agency, the Sanitary Water Board, with pollution abatement responsibilities.

Industrial cities such as St. Louis experienced their major growth between 1850 and 1950. This century was marked by great tension between the forces of growth and production and the environmental forces of nature. The *Homo sapiens*-based forces prevailed, and air, land, and water resources were debased and landscapes transformed. Two of their most significant accomplishments were to improve the quality of drinking water supplies and to eliminate dense smoke from the urban atmosphere.

In 1940, however, the St. Louis municipal government enacted the most far-reaching smoke control program to date. The city's smoke problem, like that of other smoky cities, was caused by a reliance on bituminous coal for its primary fuel. By 1900, industries, utilities, commercial sector, railroads, riverboats, and residences in St. Louis were burning approximately four million tons of coal a year. While St. Louis has an excellent urban site, it is also an area with a proclivity to fogs and atmospheric inversions or high pressure systems. Residents of St. Louis called these air pollution episodes "Londoners," a combination of trapped smoke and fog that became a common occurrence in fall and winter months.



The 1940 ordinance brought marked improvements to the St. Louis atmosphere but did not obviate predicted difficulties. Many of the problems involved the low-income population, and due to the regulations of coal quality, the price of coal per ton to individual users increased, causing hardship among many of the city's poorer residents.

On the face of it, the Great Flood of 1993 served as a reminder that despite advances in engineering and information technology, the *Homo sapiens* ability to control nature has its limits. Seen from this perspective, the Great Flood of 1993 was less a reminder of the *Homo sapiens* inability to control nature than an illustration of some people's ability to insulate themselves successfully from the vagaries of sudden environmental change.

The movement of population and industry into the low-lying floodplains north and south of downtown over the next century, along with metropolitan expansion on the American Bottoms of Illinois, placed additional people and property at risk of flooding and industrial pollution.

Urban development of the floodplain was tied directly to the coming of the railroads in the second half of the nineteenth century. Railroad companies chose to lay their tracks in the floodplains leading from downtown because the flat valley floors provided an ideal surface for construction. Industries gravitate to these riverside corridors to take advantage of both rail and water transportation. To house the workers who toiled in these factories, developers erected modest homes in the vicinity, and on some portions of the riverfront, squatters raised ramshackle homes close to potential sources of employment.

To protect its new steel plant and the homes of laborers in nearby Granite City, Illinois, northeast of St. Louis and across the Mississippi River, business owners helped finance the Madison County levee, the largest protective levee in the metropolitan areas in 1893. For the most part, however, privately funded flood protection worked to the advantage of highly capitalized enterprises rather than to the benefit of residential

property owners. It is instructive to note that while the Madison County levee staved off disaster for the factories and working-class residents of Granite City during the 1903 flood, an African American community located further downstream had no such protection and was inundated by the Mississippi River.

Indeed, for some residential communities, the cumulative effect of levee construction in some areas exacerbated the destructiveness of periodic flooding in unprotected areas. By obstructing the free flow of water across lowland areas, the levees only squeezed greater volumes of water downstream; by confining the river to the narrower channel, the levees pushed water past the city at ever higher levels.

As early as 1851 civic leaders recognized that floods in the Mississippi Valley were increasing in height because levee obstructions forced the river to rise higher and flow faster downstream to discharge the volume of water that, prior to levee construction, had been more widely distributed. Subsequent investigations showed the problem growing worse as more railways inclines, protective levees, piers, and warehouses crowded the riverfront. Although the floods of 1881 and 1951 carried nearly the same amount of water, the latter passed the city at a level six and a half foot higher than the former.

Rainwater that once seeped into the soil to replenish groundwater supplies was now siphoned to the Mississippi River, adding to the total flow. Sediment accumulation along the river bed also raised the water level. River confinement, however, remained the primary culprit of worsening floods.

An emphasis on moving water away from developed areas as quickly as possible was shared by residents of New Orleans as well. Frenchman Henri D'Arcy (1803-1858) is the father of hydrogeology and his fellow countryman, biologist and naturalist, Jean-Baptiste Lamarck (1724-1829) coined the term "hydro-geology" in 1802. By the mid nineteenth century much was known about the principles of groundwater recharge (Howden, Mathers, 2013). The science of hydro-geology would have been available to decision-makers in the early years of both cities. However, the early emphasis of hydrogeology was on the identification of water supplies, and with

the Mississippi River ever-present, it is likely that residents of both New Orleans and St. Louis were not concerned with finding a water supply but rather with protecting their cities from flooding. Ground water recharge was likely not a primary consideration, and, in fact, did not become a matter of public knowledge in New Orleans until after Hurricane Katrina when alternative means of managing storm water became part of widespread community discussion.

Industrial development hinged upon flood protection. In 1947 a group of industrialists who operated facilities along the riverfront spearheaded the campaign for federally funded flood protection by forming the St. Louis Flood Control Association.

The proposal, as originally drafted, included provisions to contain the River des Peres which was subject to backflow from the Mississippi River at high water stages. Ironically, the channelization of the river in the 1920s and 1930s, which somewhat reduced the risk of flooding, spurred new residential and industrial development along the river's banks in south St. Louis thereby exposing more people to a danger that still existed.

Only where property values were high (or were expected to increase because of flood control) did the United States Corp of Engineers recommend the allocation of public funds. In 1959, construction began on a network of concrete flood walls and earthen levees stretching from Maline Creek in the city's northern reaches to Chippewa Street, eleven miles to the south. Because funding for the project was subject to a cost-benefit analysis, the flood wall stopped where factories and warehouses gave way to residential areas of lower value. Only in one section of Carondelet did cost-benefit ratios work out favorably for flood protection, largely due to the presence of industry.

The inherent biases contained within the federal funding formula were evident during the Great Flood of 1893. While the factories remained dry behind the massive floodwall, the residential communities located a little farther south were awash in muddy water. Damage was especially severe in Carondelet and the south St. Louis neighborhoods alongside the River des Peres.

Brown rats have long been a health problem in the city. By the 1950s, the most thoroughly infested area of the city was the Mill Creek valley. Here, in what was the city's worst slum area, 90 percent of all households lacked private baths while more than half had no running water. Most of the inhabitants were African American. Disinvestment by property owners, many of whom probably lived in other parts of the city, had left virtually the entire neighborhood in a state of dilapidation by the end of World War II.

In time, the rat problem in the Mill Creek valley was resolved, but only because the entire neighborhood was razed for urban renewal. On August 7, 1954, Mayor Raymond Tucker announced plans to demolish 5600 dwelling units covering 565 acres in the Mill Creek valley from Union Station to St. Louis University. The area was home to nearly 20,000 people, many of them poor African Americans who had migrated north from the agricultural areas of the Mississippi River delta. More than half of these homes lacked running water and 80 percent did not have interior bathrooms. The city passed a \$10 million bond issue for demolition that was endorsed by the local chapter of the National Association for the Advancement of Colored People (NAACP), the national organization that advocated for African Americans. Work began in 1959, but the area never attracted the investment that Mayor Tucker envisioned. (O'Neil, 2009). As displaced residents filtered into neighborhoods on the city's north side further concentrating poverty in the city, disinvestment in basic infrastructure followed.

In studies throughout America, it has become clear that exposure to toxic pollution correlates with class and race: poor and minority residents tend to live closest to hazardous waste sites. In St. Louis, it is difficult to find conclusive evidence of deliberate racism on the part of polluters, but class and race have been determining factors in exposure levels. Today the total number of sites in the St. Louis area where there is the potential of hazard to *Homo sapiens* health and the environment exceeds three hundred. Of these sites, at least fifty have been deemed sufficiently serious by federal and state regulatory agencies to warrant investigation or remedial action. The high number of hazardous sites within the St. Louis region, is in part related to the region's ecology. The opening of lead mines in southern Missouri around mid-

nineteenth century made the city an ideal location for the manufacture of various lead products. Most St. Louis homes built prior to World War II were coated with lead paint. Since 1942 with the processing of uranium ores for use in the manufacture of atomic weaponry, the disposal of radioactive materials has posed a problem for St. Louis.

Other forms of pollution have also been issues in the evolution of St. Louis. For instance, dioxin-contaminated oil found its way to twenty-seven sites, one of which was Times Beach, seventeen miles southwest of St. Louis, covering more than 202 hectares (500 acres).

Today, the town is abandoned. In another site, along the riverfront just south of downtown St. Louis, workers at one factory spilled more than 54,553,080 liters (12,000 gallons) of organic solvents over a thirty-six-year period in the process of cleaning paint from stencils.

Toxic waste sites in St. Louis originated as landfills or dumping grounds that accept wastes from a wide variety of industrial plants. Among the most notorious of these sites is a small stream that runs through Sauget, Illinois, known by the appropriate name of Dead Creek. From the 1930s through the 1970s, manufacturing at in Monsanto (Illinois) handling materials too toxic for the sewer system used Dead Creek as their depository for wastes, and it remains there. The volume of contaminated material there is estimated at more than 7.5 million cubic yards, enough to fill 200,000 large dump trucks. The toxic stew at Dead Creek includes chlorobenzene, PCBs, dioxins, and assorted heavy metals and pesticides.

Numerous recent studies suggest that in the 1990s, African Americans and the poor are disproportionately represented in St. Louis neighborhoods contaminated by abandoned toxic waste sites. In some cases, the proximity of hazardous sites to African Americans and the poor may be due to the deliberate placement of these facilities, but other evidence indicates that the social bias in levels of exposure has had far more to do with inequities in the real estate market over the past forty years than deliberate racism. In other words, sites for industrial wastes are routinely relegated to areas where land

values are depressed or relatively low, and often, these areas are the only areas where those of limited financial means (and little political clout) can afford to live and cannot afford to leave.

Most of the chemical companies and heavy industries responsible for generating the wastes at these now-abandoned sites operated facilities in either inner-city areas along the riverfront in St. Louis or in East St. Louis, for example, or in heavily industrialized suburbs such as Wellston, Missouri. Few of these were African-American neighborhoods when industries first introduced hazardous substances to the local environment, but there were exceptions. Large sections of East St. Louis, for example, have been inhabited by both African Americans and polluting industries since the 1940s. But because heavy industry relied on a predominantly white labor force in years immediate after World War II, surrounding neighborhoods tended to be populated by white, working-class families. The presence of pollution contributed to the flight of white residents and, therefore, the depreciation in property values, especially after 1970 when Americans developed a heightened environmental awareness.

In 1916, St. Louisans approved an ordinance that would prevent anyone from buying a home in a neighborhood more than 75 percent occupied by another race. While civic leaders opposed the initiative, it passed with a two-thirds majority, becoming the first referendum in the nation to impose racial segregation on housing. After the US Supreme Court made the ordinance illegal the following year (in *Buchanan v. Warley*) some St. Louisans reverted to racial covenants, asking every family on a block or in a subdivision to sign a legal document promising to never sell to an African American (Cooperman, 2014). In the northern, western, and southern reaches of the city, developers and property holders frequently inserted restrictive covenants in their deeds to prevent the sale of homes to racial minorities. These practices continued until 1948 when the US Supreme Court struck down the practice (*Shelley vs Kraemer*). After World War II, slum clearance programs displaced thousands of African Americans from their homes, forcing them to seek housing in new areas of the city. Although the striking down of restrictive covenant enforcement in 1948 and the passage of the Fair Housing Act in 1968 facilitated the movement of

African Americans into neighborhoods that had once been off-limits, many areas of the metropolis remained closed to them by the organized actions of the St. Louis Board of Realtors who often refused to sell homes in white neighborhoods to African Americans.

#### **B.1.11 Race and Place**

Following the Civil War, African Americans settled almost exclusively in a few north-side tracts, the old industrial suburbs on the Illinois side, and scattered outposts like Kinloch in north St. Louis County. These settlement patterns continued in the 1950s. White settlement retained its overwhelming suburban orientation, and flight from the city was now evident in all but a few southern tracts of the city. African American settlement now reached the city limits along the northern border of Forest Park, concentrated in tracts being abandoned by whites.

The 1950s also saw swaths of black depopulation, particularly in the downtown and Mill Creek tracts, being “cleared” for urban renewal. Between 1950 and 1970, close to 60 percent of the 1960 white population fled the city. The same period saw only a slight in-migration of African Americans (about 12 percent of the 1960 population), although most of this influx occurred before 1960. Neighborhood surveys in the late 1960s suggested that most African Americans moved merely to stay ahead of urban renewal bulldozer, selecting from limited options including public housing, another “blighted” neighborhood, or the transitional neighborhoods spilling northwest into the County. Whites, by contrast, moved largely to escape the path of racial transition, settling in the city’s Southside or in the county’s suburban reaches.

The only significant pockets of African Americans outside the city’s north side were across the river in East St. Louis and in the old “free black” enclave of Kinloch in St. Louis County. Demographers measure such segregation in a variety of ways. Most common are the measure of evenness (or the dissimilarity index) which gauges the distribution of racial groups across a metropolitan area or the difference between patterns of settlement citywide and those in local settings (usually census tracts). The result is a citywide score, reflecting the percentage of the population that would have to

move to achieve racial balance. In St. Louis, the segregation index jumped from about 50 percent to over 80 percent between 1910 and 1930 and then settled; the 1980 index (83.8 percent) was essentially the same as it had been in 1940 (84.6 percent). Through most of this era, segregation indices hovered around the mid- to-high 80s, placing St. Louis among the nation's most segregated urban areas. Considering four other measures, including exposures (the likelihood of contact between majority and minority groups), concentration (the actual space inhabited by minority groups), centralization (concentration in the central city) and clustering (the proximity of minority tracts to each other), St. Louis in 1980 ranked as one of a handful of "hyper-segregated" metropolitan areas.

Suburban flight was about people, but it was also about money. Moving out was an economic opportunity enjoyed disproportionately by those able to clear two hurdles: the racial restrictions embedded in private and public realty and the cost of homeownership. Those who left the city were overwhelmingly young, white adults and their families; left behind were two groups, African Americans of all ages and the elderly.

During the 1960s and the 1970s, realtors orchestrated the racial transformation of many industrial neighborhoods using a technique known as blockbusting. Employing the fear of integrated housing to scare white homeowners into selling their property at cheap rates, realtors resold homes to African Americans with limited housing options and turned a tidy profit in the process. In this way, entire neighborhoods changed from white to black in a matter of years.

The economic decline of the 1970s and subsequent white flight to St. Louis County further advanced segregation. For instance, in Wellston, Missouri, a blue-collar community that once employed thousands of people in manufacturing jobs mostly in the electrical industry, the percentage of white residents fell from 91 to 30 percent between 1960 to 1970 (Gordon, 2014). With poor housing stock and few civic improvements, Wellston became a primary place of relocation for African-Americans displaced by urban renewal efforts in the Mill Creek valley. Industrial districts along the riverfront just north of downtown experienced a comparable swing in the following



decade. The African American families, which were guided *en masse* into neighborhoods such as Wellston and north St. Louis, rarely had any idea of the environmental time bombs that lay ticking in their backyards.

Segregation of the city was driven by three major factors. First, suburbanization exploded the spatial dimensions of the metropolis, thereby affording privileged groups greater opportunities to remove themselves from zones of poverty, pollution, and decay. Consider the fact that from 1950 to 1990, land use increased by 455 percent while the population grew by only 33 percent. The channeling of investments in the physical landscape to newer developments has produced stark contrasts between the postwar suburbs and older inner-city areas in terms of the condition of recreational facilities, the quality of the physical infrastructure, and the celebrity of air. Second, divisions of class had become increasingly correlated with divisions of race. Because post-war suburbanization had been, for the most part, a white phenomenon, African Americans were disproportionately relegated to inner-city districts saddled with decaying physical structures and waste. Third, the relationship among the three variables of environmental quality, race, and class has become increasingly embedded in public policy, in the cost-benefit formulae that govern the location of environmental improvements, and in the selective enforcement of laws. Beyond debate is the fact that, over the two hundred years that St. Louis has been a community, the benefits and liabilities of environmental change have not been equally distributed among all its residents.

In St. Louis and elsewhere, is the undisputed law of urban decay that rising incomes breed suburbanization; suburbanization robs inner cities of their tax bases; resulting inner city concentrations of poverty widen gaps between urban residents and substantive economic opportunities and between suburban residents and urban concerns. All this adds up to urban decay, and encourages more flight not only from the metropolitan core but also from decaying inner suburbs as well. This pattern, the monotonous backbeat for most accounts of the modern urban crisis, was identified in St. Louis as early as 1919. Residential opportunities were determined less by supply and demand than by the ways in which private choices were made, regulated, restricted, or manipulated. Private real estate restrictions crowded some residents (in

St. Louis, it was largely African American) into a few older neighborhoods, effectively limiting their escape to the suburban fringe. Municipal zoning replicated and reinforced these restrictions, creating a metropolitan centrifuge of exclusive land-use regulations that drew both private wealth and public tax capacity from the central city. Yet, because these vastly divergent opportunities were embedded in an arcane patchwork of private standards and public subsidies, the central illusions prevailed: that individual choices and not public policies were re-shaping the city, and that racial segregation flowed from an unfortunate but understandable defense of private property rights.

If this was a market at work, it was not only corrupt but starkly inefficient. Over time the accumulation of individual residential choices achieved no equilibrium but only hardened patterns of residential segregation and, by robbing the central city of its tax base, encouraged even more people to escape the fiscal wreckage (basic public services, underfunded schools) left behind. Over time, cities, including St. Louis, dipped below the demographic and economic thresholds necessary to sustain even basic urban activities or expectations (public transit, downtown retail opportunities, leisure activities, and industrial clusters). As social and fiscal challenges accumulated, the political clout of cities throughout the county evaporated, and over time, the logic and consequences of urban decay crept outward from the inner cores, extending into inner-ring suburbs as well.

Just as industrialization helped build the city, so de-industrialization contributed to its decline – a pattern of change that flowed as much from city to suburb as it did, ultimately, across national boundaries. This urban crisis was particularly severe in St. Louis, a community that bore the brunt of both demobilization after World War I and urban de-industrialization later in the century. In these respects, St. Louis, whose local economy was rooted in the commerce of the Mississippi River, lagged even its regional peers whose economic foundations (rail in Chicago, automobiles in Detroit) at least belonged to the twentieth century. Surveys and city plans, on both the Missouri and the Illinois sides of the river, suggested serious economic and demographic problems as early as 1920.

By the 1970s, St. Louis was clearly the epitome of the nation's urban crisis, with national assessments such as this: "By almost any objective standard," *The New York Times* reported in the late 1970s, 'St. Louis is still the premier example of urban abandonment in America.' Even more recent and hopeful assessments of "comeback cities" routinely dismiss St. Louis as a persistent underachiever. (Gordon,2014)

#### **B.1.12 The De-industrialization of St. Louis**

Historically, land along the Mississippi River at the northern boundary of the city was put to industrial use. This land was the portion of St. Louis closest to the confluence of the Missouri, Illinois, and the Mississippi rivers and thus offered a convenient location for the loading and unloading of goods transported by those rivers. The 6,000 acre St. Louis Port Authority controls a 70-mile long stretch on both sides of the Mississippi River and today is within 500 miles of one third of the population of the United States population. It is the 17<sup>th</sup> largest port in the United States and the second busiest inland port. The centerpiece of this development, the 70-acre Municipal River Terminal, is the only general purpose dock in the region on the west side of the Mississippi River.

This location as a site for commerce was enhanced with the construction in 1874 of the Eads Bridge, the first crossing of the Mississippi River. The bridge landed at the southern terminus of North Broadway further supporting this location as a site for industry and commerce. The St. Louis municipal dock was built on North Broadway in 1918. In 1924, the US Congress formed the Inland Waterways Corporation tasked with promoting river transport and barge operations, providing funding and support for the further expansion of port facilities.

Due to the proximity to these rivers, the north riverfront (North Broadway) was dominated by large lumberyards and mills, grain elevators, foundries, and several freight terminals and North St. Louis in general. Along South Broadway there were smelters, chemical plants), foundries, breweries, and another cluster of rail terminals.

Downtown St Louis was the center for finance, trade, and light industry. The Illinois side of the river was also a thriving, rail-based industrial district, composed mostly of steel and metals industries but also the massive National City meat packing complex. By the late 1920s, in turn, many of the city's heavy manufacturers, excepting the clay industries reliant on Missouri deposits, had migrated to the Illinois side.

As in the nation, the coming of World War II ended the Depression in St. Louis, but the post-World War II population boom that swamped the housing market and local services out-paced the economic boom in St Louis as in many other war-era industrial centers. Post WW II, the city got a small share of new investment in aircraft assembly and was the nation's leading supplier of ordnance for the armed forces. Greater St. Louis emerged from the WWII in relatively good shape, boasting a substantial (if only marginally diverse) manufacturing base and the nation's second largest rail and trucking hubs. But this period marked the peak of industrial growth for the region and especially the city of St. Louis itself.

In the city, itself, the employment base collapsed alongside its more general de- population. Indeed, over the post-war era, the city's share of regional employment dropped dramatically from about fifty percent in 1950 to just over 10 percent today. Employment in St. Louis County, by contrast, grew quickly after the war and leveled off. Employment on the Illinois side (as a share of regional employment) remained relatively stable while the share of the outlying Missouri counties grew modestly.

Much of the county's success reflected natural economic growth. As the entire metro area grew, new investment flowed disproportionately to suburbs where new industrial sites (especially along major thoroughfares and surrounding the airport, Lambert Field) were readily available.

In 1973, city leaders felt that St. Louis might well be at a "tipping point" in the city's economic history and would may soon be going downhill too fast to turn around. De- industrialization had set in, and the employment totals for the MSA and its constituent counties declined in tandem, although the city continued to count losses to

poaching by neighboring counties. St. Louis County's biggest prize, in the early 1980s, was the relocation of the city's General Motors plant – a loss bemoaned by St. Louis officials but celebrated by the Regional Commerce and Growth Association as “retention.”

Along with its industrial base, the city also lost managerial employment, a trend exaggerated by the willingness of local firms to move their headquarters out to St. Louis County and beyond, even if production remained in the older industrial core.

In 1953 and 1964, the adjacent city of Clayton, just west of St. Louis, saw the construction of forty-six new commercial buildings (during which time the city claimed only three new developments) and by 1966 boasted two million square feet of office space, nearly one-third of what was available in St. Louis itself. Even the United States Department of Commerce moved its local offices out to Clayton on the understanding that “by any yardstick you care to use, St. Louis County is the center of the St. Louis metropolitan region.” Perhaps most dramatically, St. Louis lost virtually its entire retail base over the course of the post-war era, dropping from over 75 percent of regional retail sales in the late 1940s to barely 11 percent in the late 1990s.

In turn, local and federal tax laws created incentives to abandon downtown altogether for concentric rings of suburban malls. Beginning in the mid-1950s, federal depreciation rules encouraged new development at the expense of the renovation or rehabilitation of older commercial properties. This economic incentive first hit downtown properties but subsequently encouraged investors to abandon first-generation shopping malls in the inner-ring suburbs too as soon as something bigger and better could be built farther out.

Certainly, the most dramatic element of St. Louis post-war history is the depopulation of the city itself. The state's decision to split St. Louis from the rest of St. Louis County in 1876 effectively froze the size of the city at 61 square miles. New residential development beyond the city's borders cropped up first along railroad lines. Initially an option for only the more affluent city residents, these “railroad suburbs”

were made more and more accessible by private trolley and streetcar lines and, after 1920, by the automobile. In the middle decades of the twentieth century, a combination of demographic change, racial restrictions, and federal subsidies made the suburbs (at least for the city's white residents) both preferable and affordable.

While mobilization for World War II temporarily reversed the city's decline, the population losses first noted by planners in the 1920s and 1930s soon returned. The city's population peaked at just over 850,000 in 1950, at which point St Louis claimed just under half (47.9 percent) of the population of the metropolitan area. The city lost an average of just over 10,000 persons a year between 1950 and 2000, during which time St. Louis plummeted from ninth to eighteenth in the national rankings of metropolitan areas. Of the 15 largest metropolitan regions in 1980s, only Boston and Pittsburgh had economically weaker central cities. Suburbanization was shaped by racial restrictions that both denied African Americans the same residential mobility and, as spatial segregation deepened, exaggerated the motives of those who wanted out. Again, this was a partnership established early in the century, cemented by the demographic and political changes in the 1940s, and exaggerated in St. Louis by the fixed boundaries, aged housing and industrial stocks, and substantial rural hinterlands.

#### **B.1.13 Tax Policy and Fragmentation**

The politics of property and race rest not just in the motives of local interests but also in the discriminatory opportunities facilitated by fragmented local governance. State and local laws regarding incorporation, annexation, and consolidation vary wildly, but in most settings, they have made it easy to incorporate new localities on the City's fringe. By law and practice, the city was a quasi-public corporation, subject to regulation by the state but without "state" powers itself. The solution, for local and state politicians alike was "home rule" a delegation of state powers to local governments. It gave cities the option of adopting charters of self- government, a provision (limited at the time to cities with populations over 100,000) written expressly for the city of St. Louis. Under the 1876 constitution, no city or town could incorporate

within two miles of the corporate limits of another city in the same county. But since St. Louis was legal prevented from expanding into St. Louis County, numerous municipalities formed at the edges of the city.

Early on, the conventional pattern of urban growth—annexation of outlying, often industrial, suburbs—was blocked in St. Louis, whose western border was sealed in 1876 and whose industrial suburbs were largely on the Illinois side of the river. St. Louis County claimed six incorporated municipalities in 1900 and only twelve more in 1930, but that number had more than doubled by 1940 and doubled again by 1950. The driving force behind this, or course, was the rapid residential development of St. Louis County, which added over 225,000 single-family homes between 1950 and 2000.

City planners routinely discouraged their St. Louis County clients from annexing new territory—arguing instead that smaller municipal units (population 8,000-10,000) were sufficient to provide local services and necessary to avoid the threats posed by mixed density or use. By and large, suburban municipalities existed to sustain local residential standards and patterns. Especially in the decades following World War II, subdivisions incorporated as a means of staving off annexation by their larger neighbors. This pattern became even more common after 1929, when established cities began looking to weather the fiscal crisis of the Great Depression by padding their property tax base by incorporating developments outside their boundaries.

The 1979 county charter established a new countywide sales tax but allowed municipalities to opt out and claim local revenues. This gave these “point of sale” cities powerful incentives to add new retail districts by redevelopment or annexation.

The result, routinely noted by local officials, was an almost mind-boggling patchwork of political authority in St. Louis County. The grand total for the metro region (as of the 1997 census of governments) reveals the following: 789 political units, an average of 12.5 “general purpose” (excluding school and other special districts) governments for every 100,000 residents, nearly three times the average (4.4 per 100,000) for the nation’s 15 largest metro areas. State law consolidated local school

districts in 1948, cutting the statewide total by more than half and reducing the number in St. Louis County from over 80 to about 30.

County school districts and municipalities coalesced against efforts to reorganize the metropolitan area into 20 integrated school districts that would segregate pockets of African American students (most notably in Kinloch) until 1975 when they were compelled by the courts to re-draw boundaries. This fragmentation, in turn, facilitated and invited a prolonged pattern of local piracy as political units sought to maximize local wealth and tax bases while minimizing any claims that might be made on them.

Home rule has encouraged local poaching of retail development, hardened local inequalities, and forestalled any functional regional response to serious social and economic challenges. Despite a near consensus that transportation (public and highways) posed the greatest regional planning challenge, the idea of a special transit district stalled, leaving only the Bi-State Development Agency, a combination planning body and bridge/harbor authority, without any taxing power.

A more serious regional perspective, which continued to view metropolitan governance as a solution to regional and central city problems, fell to organizations like the East-West Gateway Coordinating Council (now the East-West Gateway Council of Governments). Members of the new board of aldermen were (in keeping with the state constitutional provision) elected at-large, although each nominally represented one of the City's 28 wards. For most of the modern era, the institutional and electoral dimensions of St. Louis politics have been dwarfed by the local policies of growth. Local taxation in Missouri is fragmented and complex, like the pattern of local governance, faced with exceptional burdens, local governments can also resort to municipal debt, usually in the form of project-specific (highways, re-development) bonds.

The politics of property assessment underscored the larger vulnerability of property tax as a political target and as a source of local revenue. Across the modern era, state and local pressures carved away at the tax base at both ends: proliferating



exemptions and credits were crafted both to protect low-income Missourians from rising property values and to encourage new investment and development.

By 1960, the earnings tax accounted for about one-quarter of city revenues. By 1970, it was more important than the property tax, and by 1990 it generated more than three times the revenue of the property tax. The one percent earnings tax is an income tax collected from all city residents and non-city residents who work within city limits. These funds comprise one-third of the city's budget and are directed into the City's general fund.

Inescapably, the politics of local taxation and patterns of local fragmentation combined to produce sharp inequities across the metropolitan area and severe fiscal stress, first for the central city, and later for its older, inner-ring suburbs. The ability of local governments to provide local services was shaped by their "fiscal capacity," essentially the relationship (or gap) between available revenues and the cost of necessary services. As urban planners and local governments keenly appreciated, a municipality of large-lot single-family homes with perhaps a new shopping mall generated stable revenues and minimal demands. The city and its inner suburbs, by contrast, increasingly struggled to generate property, income, and sales taxes—while facing substantially higher demands for municipal services such as local schooling, police, infrastructure, maintenance, and social assistance.

The state mandated the consolidation of many school districts in 1948. In the 1980-81 school year, average daily K-12 attendance (about 63,000) was barely half what it had been a decade earlier, and in that academic year alone, the St. Louis Board of Education closed 28 schools. By 2000, subsequent adjustments in school district boundaries reduced the number of school districts in St. Louis County (even as new municipalities proliferated). Assessed values in the city collapsed during the Great Depression and did not recover to prewar levels until 1951 reducing educational funding.

Alongside the declining importance of the property tax, city leaders focused attention on local disparities in revenue, and particularly on the burden of carrying

“blighted” properties on the tax rolls. Their findings confirmed the long-standing arguments of city planners that inner-city residential districts cost far more to service than they collect in taxes, and that these “blighted areas” were effectively subsidized by commercial and higher-end residential neighborhoods elsewhere. Sub-standard housing stock accounted for barely six percent of City revenues but fully 45 percent of city spending.

This, in St. Louis, New Orleans, and elsewhere, was the legacy of fragmented metropolitan governance. Successive rings of suburban development poached the central city – and later the inner-ring suburbs as well—of their population, their wealth, and their taxable value. Greater St. Louis was bound up in a tangle of local, state, and federal policies that explicitly and decisively sorted the city’s growing population by race the effects of which remain today. These policies yielded both an intense concentration of African Americans in certain wards or neighborhoods of St. Louis itself and a virtually wall between the city and its suburbs. At the center of this story was the local realty industry. Among the tactics, they employed, dating from the WW I years, were explicitly racial zoning; enforced race-restrictive deed covenants into the middle years of the century; pioneering practices of residential security rating, which governed both private mortgages and public mortgage guarantees; and, as a central precept of industry practices, actively discouraged desegregation of the private housing market.

Covenants served essentially the same purpose as zoning: by setting contractual standards for land use, they freed developers and homeowners from the vagaries of nuisance law and bound future owners to the same standards. These restrictions, which in most states could not legally last in perpetuity, ran for terms of 20 to 50 years, binding both the original signatories and any successors in ownership. In settings, such as St. Louis, racial occupancy was the focal point of both original deed covenants and restrictive agreements. The earliest covenants did not specify racial restrictions because black occupancy of such properties was not even a remote possibility. But race restrictive agreements began to appear as early as 1911, a legacy of post-Civil War “Jim Crow” laws. The urgency of race-restrictive-covenants heightened in response to the “great migration” of African Americans from the rural

South to urban areas, spurred by World War I. St. Louis covenants typically ran no more than a couple of city blocks and often split those blocks, covering the houses facing each other across a street rather than the actual block. Covenants were common in new developments. Indeed, observers estimated that as much as 80 percent of the new suburban housing stock that sprawled west into St. Louis County contained such agreements. Across the north side, restrictive agreements were cobbled together like links in a chain. Suddenly, black tenants and owners faced court orders to vacate their homes. Although the reach and legal hold of deed restrictions was uneven, their spatial and political logic was clear: taken together, the north side covenants were clearly aimed, as both realtors and signatories understood them, at stemming the “contagion” of black residency “spreading westward” or to block “colonization” of which neighborhoods “at the point of threatened invasion (Gordon, 2014).”

The result was a boundary composed of the Mississippi to the east, the commercial core of downtown to the south, and restrictive covenants to the west and the north. “The lack of housing facilities for Negroes in St. Louis is critical for peculiar reasons. Approximately 97% of the Negro population in St. Louis lives at the geographical heart of the city, surrounded on the east by the commerce and business, and on the south, west, and north by neighborhood covenant agreements (Gordon, 2014).”

The professional code of the National Association of Real Estate Boards (NAREB), first adopted in 1924, specified that “a Realtor should never be instrumental in introducing into a neighborhood a character of property or occupancy, members of any race or nationality, or any individuals whose presence will clearly be detrimental to property values in that neighborhood.” During the in-migrations that accompanied both world wars, realtors and property owners in neighborhoods “threatened” by racial integration redoubled their efforts to corral African American occupancy. Each era, in turn, was marked by legal challenges to such efforts, resulting in US Supreme Court decisions prohibiting racial zoning (*Buchanan v. Warley*,) in 1917 and state enforcement of restrictive covenants (*Shelley v. Kraemer*,) in 1948. Yet, as late as 1962, the American Institute of Real Estate Appraisers defined “neighborhood” as an “area exhibiting a high degree of homogeneity as to housing, tenancy, income, and population

characteristics.” Clearly not much had changed regarding racial segregation in real estate markets, even with legal opinions to the contrary.

### **B.1.13 Zoning**

Viewed from an ecological perspective, zoning may be considered an effort to reduce patch dynamics – the movement of land use and populations across space and time. Zoning seeks to establish equilibrium and predictability on an otherwise dynamic landscape. Zoning meant very different things to St. Louis and its suburbs. In suburbia, the dominant practice (emerging in the middle years of the twentieth century) was “exclusionary zoning” and involved land-use controls that ensured a pattern of predominantly low density, single-family settlements through a combination of outright prohibitions (heavy industry, manufactured housing), effective prohibitions (no land zoned for multi-family housing), and area or density standards (minimum for lot size, setbacks, and building size). Older cities, by contrast, did not have the power to zone until long after local land use had been decided by private restrictions and market forces.

Exclusive and fragmented zoning in the suburbs erased any semblance of residential diversity, sorting the white middle class into income-specific single-family enclaves on the periphery and leaving African Americans, the elderly, and the poor to filter into older and higher-density central-city housing stock, (much of which was unprotected by local zoning. And, over time, exclusionary zoning created a stark spatial mismatch between the availability of jobs and the availability of affordable housing. New forms of zoning, such as form-based codes, are intended to reserve this historical fragmentation and to create districts more diverse in terms of land uses and populations.

Local zoning had to protect the interests of the entire community and do so evenly and indiscriminately. Municipalities offered increasingly expansive definitions of “nuisance,” a legal designation that came to include not only its original targets but also almost any other business that did not “fit” in each neighborhood, including racial occupancy as well. State enabling acts and local zoning laws embraced two basic

principles: separation of use and control over density. Each municipality in this respect sought to isolate and protect large single-family districts, to exclude those likely to make demands on public goods and public services, and to accomplish a residential density sufficient to provide basic public services at a reasonable tax rate. For example, LaDue, Missouri, a suburban community adjacent to St. Louis, allows no multi-family development within its boundaries. Zoning, therefore, reduces both the dynamism or movement of patches and the diversity of patch types. The City of St. Louis' first general zoning ordinance (1918) was based on an expansive use of the police power and new charter powers won in the election of 1914.

Before World War I, the only land use controls in St. Louis were building permits and piecemeal exclusions in response to the complaints of neighbors. The first attempt at a full-blown zoning ordinance, however, came not from professional planners but from the City's anxious and segregationist real estate interests, who won a racial zoning ordinance by popular referendum in 1916.

This zoning activity was organized around the conviction that "blight" was caused by the City's inability to protect residential properties from the incursion of industry, commerce, and substandard housing. The distinction among the use districts were somewhat crude by contemporary zoning standards. It is a stretch to dignify the 1918 and 1925 zoning ordinances as "planning." Since St. Louis was already substantially built, zoning was less a blueprint for the future than it was a means of protecting existing investments and managing neighborhoods transition. The ordinance was not retroactive, and it imposed no real penalties or pressures on non-conforming uses. The architects of the zoning districts readily admitted that they were essentially descriptive and were determined largely by existing patterns of development.

The other major undercurrent in the early zoning debate, not surprisingly, was race. The 1918 and 1926 ordinances used private streets and deed restrictions as a general guide for its most exclusive residential districts. The 1918 districts were prepared primarily with the view of protecting the more desirable residential neighborhoods. City planners went so far as to suspend the rule that parks be built in residential zones as a means of discouraging African American activities in white

neighborhoods. Even the location of commercial or industrial districts was often posed as a racial issue. The local Chamber of Commerce distinguished industrial from unrestricted districts because the former allowed light industries “which are in no way offensive, which will employ clean and self-respecting men and women, who will, as a rule, live in nearby homes.” The racial premise of zoning emerged most clearly in areas of established black occupancy running from the central business district west to the Ville and the contested neighborhoods surrounding it. “A decade ago the Zoning Commission left not a single block or neighborhood zoned as residential in the area from Delmar to Labadie,” the Urban League noted in the late 1930s, and “this wide Negro section was zoned as multiple dwelling, commercial, and industrial district.” What emerged instead was a pattern of “exclusive zoning,” (Hurley,1997) which systematically under zoned African American neighborhoods.

The 1947 St. Louis City Plan recycled the catalogue of problems (commercial over zoning, nonconformance, spot zoning) first identified in the 1930s and labeled the St. Louis zone plan “one of the most obsolete ordinances to be found in any of the large cities of the United States. “ (Hurley,1997) After passage of the 1950 ordinance, St. Louis did not revisit its zoning policies in any serious way until the late 1970s, a surprising indifference given the scale and severity of the unfolding urban crisis.

By 1980, the zoning ordinance was increasingly marginal to the politics of planning in St. Louis. In part, this reflected the dramatic de-population of the City. The neat formulaic patterns of residential land use suggested by the zoning ordinance largely evaporates when building vacancies and nonresidential uses are considered. Residential zones, after all, offered little to neighborhoods in which no one lived anymore.

In St. Louis County, by contrast, zoning proceeded alongside development and was instrumental in shaping patterns of residential land use. Each of the municipal governments in St. Louis County had every incentive to maximize tax revenues, stabilize property values, and minimize demands on local government, a combination best accomplished by creating large- lot single-family enclaves. Fragmented zoning, in

this respect, came most directly at the expense of the City of St. Louis which shouldered many of the costs of urban development, since the suburbs poached its population, retail trade, and employment base. But it also came at the expense of the suburbs themselves. All local governments bore the cost of administrative disarray and unmanaged sprawl. Suburbs engaged in often destructive competition to attract (and avoid) new residential or commercial development. Over time, newer subdivisions and incorporations to the west were poaching not just the city but the older inner-ring suburbs as well.

In only a few settings (including Maplewood, Ladue, Webster Groves) did local zoning precede development. As of 1950, barely a third of the metropolitan area's municipalities had a local zoning ordinance on the books. Once developed, these areas often looked to municipal incorporation to maintaining community standards, perpetuating the spirit of private deed restrictions, and forestalling annexation by neighbors.

Suburban zoning ordinances followed the logic of systematic exclusion. These strategies include stark restrictions on multi-family housing (apartments, townhomes, duplexes). Indeed, the rule in the first wave of zoning beyond the inner-ring was to make no allowance for alternatives to detached single-family homes. In turn, residential districts were shaped by density controls including minimum lot sizes and yard or frontage requirements.

These proscriptive standards were used to protect existing properties and to shape (or forestall) new development. Municipalities (and St. Louis County) used large-lot single-family standards to raise the value of undeveloped land and create "holding zones" in which local zoning commissions could approve new construction or subdivision on a case-by-case basis.

## **Appendix C: Evolution of the United States Census**

Since the first professional census in 1880, the United States Census has continued to evolve and change. The 1890 census recorded crime, pauperism, and benevolence though statistics were recorded by state and not by ward. Similarly, the volume of real estate mortgages was recorded for the entire cities of New Orleans and St. Louis but not by ward. Residents were still listed individually, but a new questionnaire sheet was used for each family. This was the first year that the census distinguished between different East Asian populations.

For 1900, the Census Office dropped the "family questionnaire" form style and reverted to filling entire sheets of information on residents. The census recorded color or race and classified population as white, black, Chinese, Japanese, or American Indian.

The 1910 census questionnaire was similar in design to that used in 1900.

The most notable change was the addition, of a question concerning a person's "mother tongue." The 1920 census questionnaire was like, but slightly shorter, than its counterpart from 1910. "Place of abode" replaced "dwelling house" as the general term for a person's residence. There was no separate schedule for American Indians.

For the 1930 census, the population questionnaire was basically the same as it had been in 1910 and 1920. The biggest change was in racial classification.

Enumerators were instructed to no longer use the "Mulatto" classification. Instead, they were given special instructions for reporting the race of interracial persons. A person with both White and Black lineage was to be recorded as Black, no matter what fraction of that lineage. A person of mixed Black and American Indian lineage was also to be recorded as Black, unless he was "predominantly" American Indian and accepted as such within the community. A person with both White and American Indian lineage was to be recorded as an Indian, unless his American Indian lineage was very small and he was accepted as white within the community. In fact, in all situations in which a person had White and some other racial lineage, he was to



be reported as that other race. Persons who had minority interracial lineages were to be reported as the race of their father. For the first and only time, "Mexican" was listed as a race. Enumerators were to record all persons who had been born in Mexico or whose parents had been born in Mexico and who did not fall into another racial category as "Mexican."

In 1930, following the start of the Great Depression in 1929, the United States Census started to track unemployment. The spatial location of unemployment in New Orleans over time is less delineated, but one can easily see the increasing unemployment rate from 1980 to the present day, likely a product of the deindustrialization of the city (Figure 45). A visual review of a time lapse sequence of this data illustrates the de-industrialization of St. Louis over time, particularly on the north side (Figure 46).

The 1940 census was the first to include a statistical sample. To gauge the effect of the Great Depression on the nation's housing stock, a census of occupied dwellings was coupled with the usual demographic questions. The 1940 census was the first to include a separate questionnaire on the condition of the nation's housing stock.

The 1950 census population questionnaire asked fewer questions than its predecessor; and the full population was asked only 20 questions. As in 1940, a 5 percent sample was asked an additional slate of questions. The 1950 census housing questionnaire was slightly shorter than its counterpart from 1940 but retained the layout developed during that census. Additionally, the questionnaires for occupied and vacant housing were combined into one form.

For the first time in 1960, the Census Bureau mailed out a combined population and housing questionnaire to all urban residents in the United States. Residents were to complete the questionnaire themselves and hold it until an enumerator came to collect the form. Enumerators then gave an additional sample questionnaire to 25 percent of households, with instructions to mail it back to their census office. Rural residents were enumerated by traditional visitation. The census

"short form" collected only five questions: relationship to head of household, age, sex, race, and marital status. Housing questions for the 1960 census were wrapped up with population inquiries. With the 1960 census federal government began to record home ownership by census tract. Because of these housing questions, demographers can estimate areas of a city with older housing stock. Homes in the United States built before 1978 were often painted with paint containing lead. Lead paint is considered hazardous because it can cause nervous system damage, stunted growth, kidney damage, and delayed development (EPA, 2017).

Starting with the 1970 Census, the Census Tract essentially replaced the Enumeration District as the smallest area for collecting and reporting census data. The 1970 census was the first to operate on a true mail-out mail-back system. Because enumerators were only sent out to collect information from non-responding residents, the census questionnaire was designed to be filled out by the members of each household. The 1970 census was the first to provide average household income data by census tracts. A visual review of a time lapse display of this data identifies areas of low income. In many ways this average household income map corresponds to the areas of African American population, but Pontchartrain Park, an affluent black neighborhood is one notable exception (Figure 51 and Figure 52).

The first 12 questions on the housing section of the 1980 census questionnaire were asked of all respondents. The rest were asked only to a sample. As with previous censuses, some questions had set answers for the respondent to choose from; where relevant, those answers have been listed.

The 1990 census asked only seven population and seven housing questions. A sample of respondents received the "long form," which included 23 more population inquiries. The 1990 census asked only seven housing questions to every respondent. A sample of respondents were asked an additional 19 questions.

The 2000 census short form asked eight questions to all respondents. The long form, which combined housing and population questions into a single questionnaire, asked an additional 45 questions.

The American Community Survey was launched in 2005. As a supplement to the decennial census, the American Community Survey implements the concept of continuous measurement which was first proposed in the 1990s. In 2005, an annual housing unit sample of approximately 3 million addresses throughout the United States was implemented. In 2006, approximately 20,000 group quarters were added to the American Community Survey so that the data fully describes the characteristics of the population residing in geographic areas. While the American Community Survey provides valuable socioeconomic data about American cities, it is based on a statistical sampling of the United States population rather than a full count of population.

For the 2010 census, the long- and short-form questionnaires used from 1940 to 2000 were replaced by a single questionnaire asking 10 questions.

## **D: The Importance of Environmental History**

Why develop such an extensive appendix for this thesis? While excellent environmental histories of New Orleans and St. Louis exist, they do not address all the same topics. First, to provide for a comparison of the two cities, it was important to develop and organize the environmental histories along similar lines and to add additional information to complete the picture. Second, it was also important to understand the population geography of both cities and to understand how different groups moved across the land through time. Third, geographic information system based maps are essential to the analysis contained within this thesis, but without an understanding of the history of the city much would have been lost in translation. For example, an analysis of the current condition would not tell the reader about anthropomorphic modifications to the landscape including the removal of islands in the Mississippi River at St. Louis or the filling of Lake Pontchartrain in New Orleans to create land for development. Nor would current mapping reveal the clearing of neighborhoods that took place in anticipation of the construction of I-755 in St. Louis or the closing of the MR-GO canal in New Orleans, the conduit for so much flooding during Hurricane Katrina. Mill Creek which has played such a significant role in the shaping of St. Louis is now a buried sewer. The Carondelet Canal in New Orleans, and other 18<sup>th</sup> and early 19<sup>th</sup> century canals which determined the location of industrial development in the city are now gone.

Both cities saw a major influx for newly freedmen in the years immediately following the Civil War. These new residents often found homes on the marginal lands of the city. Both unsuccessfully sought to enact racially-based zoning ordinances. Both utilized racially based protective covenants to insure segregation of the population. Both employed redlining. While the physical manifestations of these major management actions can be observed by the current conditions, the management decisions themselves are only revealed through a study of environmental history. Both New Orleans and St. Louis experienced the disturbance of Interstate highways constructed through the heart of the both cities.

This thesis reveals that land vacancy is highly related to spatial and social opportunities and risks within the city and by extension lower land values and incomes. Efforts to address vacancy merely through landscape treatments of the vacant parcels themselves are likely to meet with limited success. With a deep understanding of the environmental history of New Orleans and St. Louis, however, planners, landscape architects, and civic officials can make decisions which target the root causes of vacancy rather than treating merely the symptoms.

## **Appendix E: Map Sources, Additional Maps and Charts**

### **E.1 New Orleans Map Sources**

- 1.1 1723 Plan de la Ville de la Nouvelle Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)
- 1.2 c. 1723 Carte Particuliere Du Flevue [sic] St. Louis dix lieües au dessus et au dessous De La Nouvelle Orleans (Source: Newberry Library, Chicago)
- 1.3 1729 Map of New Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)
- 1.4 1747 Plan de Nouvelle Orleans, Dumont de Montigny (Source: Norman B. Leventhal Map Center, Boston Public Library)
- 1.5 1757 Plan de Nouvelle Orleans, Joseph Bellin (Source: University of Alabama Map Collection)
- 1.6 1759 Thomas Jeffreys Map of New Orleans (Source: New Orleans Collection)
- 1.7 1759 Grondvlakte van Nieuw Orleans Thomas Salmon (Source: University of Alabama Map Collection)

- 1.8 1761 Map of New Orleans, Richard Benning (Source: Norman B. Leventhal Map Center, Boston Public Library)
- 1.9 1770 Philip Pittman Map of New Orleans (Source: Library of Congress)
- 1.10 1798, Copy and Translation from the Original Spanish Plan Dated 1798 Showing the City of New Orleans, Alexander Debrunner (Source: Historic New Orleans Collection)
- 1.11 1800 Plan New Orleans Lands from Concession De Debreuil to Bayou Gentilly (Source: Historic New Orleans Collection)
- 1.12 1803 Plan Del Local De las tierras que Rodean la Ciudad de Nueva Orleans By Carlos LaVeau Trudeau (Source: Historic New Orleans Collection)
- 1.13 1803 Plan of New Orleans, John L. Boqueta de Woiseri (Source: Historic New Orleans Collection)
- 1.14 1815 White's Map of New Orleans (Source: Library of Congress)
- 1.15 1816 Plan of the City and Environs of New Orleans, Barthlmy Lafon (Source: Historic New Orleans Collection)
- 1.16 1819 Map of New Orleans (This map is an 1873 copy of the original 1804 map copied by Pintado (in Havana in 1819) and verified by Pilié, the New Orleans

Surveyor in 1838. Map reflects information compiled by Pintado in 1795-96 and set down by Trudeau in official records in 1804, Source: Library of Congress)

1.17 1828 Extracts from a map of the City of New Orleans and its Vicinity: shewing the route of the British Invading Army in 1814, Letour Carrier (Source: University of Alabama Map Collection)

1.18 1829 Francis Barber Ogden Map of New Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)

1.19 c.1833 Topographic Map of New Orleans, Charles F. Zimpel (Source: Historic New Orleans Collection)

1.20 1834 Canal Mississippi au Lac Pontchartrain Guillaume Tell Poussin (Source: David Rumsey Map Collection)

1.21 c. 1849, Benjamin Moore Norman, Norman's Plan of New Orleans and Environs (Source: Historic New Orleans Collection)

1.22 1849, Diagram Showing the Inundated District – Sauve's Crevasse, May 3<sup>rd</sup> 1849, Von Reisenstein, (Source: Historic New Orleans Collection) |

1.23 1855 H. Walter, Plan of New Orleans and Environs (Source: Historic New Orleans Collection)



1.24 1855 Map of New Orleans, Joseph Hutchins Colton (Source: University of Alabama Map Collection)

1.25 Map of New Orleans, T. Addison Richards (Source: University of Alabama Map Collection)

1.26 1860 Plan of New Orleans, Samuel Augustus Mitchell (Source: University of Alabama Map Collection)

1.27 1861, Map of New Orleans, Charles Gardner (Source: Norman B. Leventhal Map Center, Boston Public Library)

1.28 1863, Approaches to New Orleans, Henry L. Abbot (Source: Historic New Orleans Collection)

1.29 1870s Plan de la Ville et des faubourgs incorpores de la Nouvelle Orleans, Claude Jules Allou d' Hmcourt, (Source: Historic New Orleans Collection)

1.30 1873 O.W. Gray, Map of New Orleans (Source: University of New Orleans Map Collection)

1.31 c. 1877 Topographic and Drainage Map of New Orleans and Surroundings, Thomas Sydenham Hardee (Source: Historic New Orleans Collection)

1.32 1879 City of New Orleans, D. Appleton and Company (Source: University of Alabama Map Collection)

1.33 1884 Perspective View of New Orleans and Environs from the South, Henry W.W. Reynolds (Source: Historic New Orleans Collection)

1.34 1884 Map of the City of New Orleans (Source: University of Alabama Map Collection)

1.35 Carlos Finlay (1886). Yellow Fever, its transmission by means of the *Culex* mosquito (Source: *American Journal of Medical Science*, 92, 395-409)

1.36 1890 United State Geologic Survey Quad Map of New Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)

1.37 1893 Mathew-Northrup Map of New Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)

1.38 1895 A Survey of the Mississippi River, Mississippi River Commission  
(Source: Norman B. Leventhal Map Center, Boston Public Library)

1.39 1898, New Orleans 1898, George H. Grandjean (Source: Historic New Orleans  
Collection)

1.40 1900 New Orleans Circa 1900 (Source: Encyclopedia Britannica)

1.41 1904 New Orleans Street Railway System, (Source: American  
Geographical Library Collection, University of Wisconsin Milwaukee)

1.42 1905 Yellow Fever Prophylaxis in New Orleans, 1905, Rubert Boyce (Source:  
Committee of the Liverpool School of Tropical Medicine, Williams and Norgate,  
London, 1906)

1.43 1908 Hammond Map of New Orleans, C. S. Hammond Company (Source:  
Boston Public Library)

1.44 1919 Times Picayune Map of New Orleans (Source: Norman B. Leventhal  
Map Center, Boston Public Library)

1.45 1920 Lake Pontchartrain and Maurepas (Source: Historic New Orleans  
Collection)

1.46 1922 Aerial Photography of New Orleans, (Source: New Orleans Public Library)

1.47 1926 Map of Orleans and St. Bernard Parishes Wm. E. Boesch (Source: Historic New Orleans Collection)

1.48 1929 Map of New Orleans, Rand McNally and Company (Source: University of Alabama Map Collection)

1.49 1932 USGS Map of New Orleans East (Source: [www.nationalmap.gov](http://www.nationalmap.gov))

1.50 1934 New Orleans, Louisiana Map of Greater New Orleans Louisiana William E. Boesch (Source: American Geographical Society Library University of Wisconsin Milwaukee)

1.51 1936 World Atlas Map of New Orleans, Source: Colliers World Atlas and Gazetteer)

1.52 1939 USGS Map of New Orleans East (Source: [www.nationalmap.gov](http://www.nationalmap.gov))

1.53 1949 World Atlas Map and Gazette of New Orleans, Wm. E. Boesch (Sources: Colliers)

- 1.54 1949 Aerial Photographs of New Orleans (Source: Louisiana Photograph Collection, New Orleans Public Library)
- 1.55 1951 USGS Map of New Orleans East (Source: [www.nationalmap.gov](http://www.nationalmap.gov))
- 1.56 1956 Shell Oil Company Map of New Orleans (Source: David Rumsey Map Collection)
- 1.57 1960 Aerial Photographs of New Orleans (Source: Municipal Government Photograph Collection, New Orleans Public Library)
- 1.58 1964 Rand McNally and Company, Map of New Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)
- 1.59 1966 USGS Map of New Orleans East (Source: [www.nationalmap.gov](http://www.nationalmap.gov))
- 1.60 1967 Aerial Photography of New Orleans
- 1.61 1978 Aerial Photography of New Orleans

- 1.62 1979 Champion Map of New Orleans (Source: American Geographical Society Library University of Wisconsin Milwaukee)
- 1.63 1982 Aerial Photography of New Orleans
- 1.64 1990 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)
- 1.65 1992 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)
- 1.66 1992 USGS Map of New Orleans East (Source: [www.nationalmap.gov](http://www.nationalmap.gov))
- 1.67 1993 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)
- 1.68 1994 Rand McNally and Company, Map of New Orleans (Source: Norman B. Leventhal Map Center, Boston Public Library)
- 1.69 1995 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)
- 1.70 1996 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)
- 1.71 1999 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)

1.72 2001 Aerial Photography of New Orleans (Source, Google Earth Engine, 2016)

1.73 2002 Aerial Photography of New Orleans (Source, Google Earth Engine, 2016)

1.74 2005 Aerial Photography of New Orleans (Source, Google Earth Engine, 2016)

1.75 2005 Parks and Open Space Plan, the “Green Dot” Map (Source: The Urban Land Institute for Bring New Orleans Back Commission)

1.76 2016 Aerial Photography of New Orleans (Source: Google Earth Engine, 2016)

1.77 2016 Time Lapse Sequence of New Orleans  
<https://earthengine.google.com/timelapse/#v=29.95107,-90.07153,10,latLng&t=0.09>  
(Source: Google Earth Engine, 2016)

## **E2: Map Sources for St. Louis**

### Ecology of St. Louis

- 2.1 1778 Map St. Louis to St. Genevieve (Source:)
- 2.2 1796 Victor Collett Map (Source: Library of Congress)
- 2.3 1800 Colonial Map of St. Louis (Source: Campbell House Museum)
- 2.4 1819 Map of Indian Mounds by Say and Peale (Source: Missouri Department of Natural Resources)
- 2.5 1820 Map of St. Louis Common Fields (Source: Campbell House Museum)
- 2.6 1822 Map of St. Louis (Source: St. Louis Genealogical Society)
- 2.7 1830 Ward Map of St. Louis (Source: St. Louis Genealogical Society)
- 2.8 1835 René Paul, Plan of the City of St. Louis (Source: Norman B. Leventhal Map Center, Boston Public Library)



2.9 1837, Robert E. Lee, Map of the Harbor of St. Louis, Mississippi River  
(Source: Norman B. Leventhal Map Center, Boston Public Library)

2.10 1840 Ward Boundaries (Source: St. Louis Genealogical Society)

2.11 1844 Map of St. Louis by Rene Paul (Source:)

2.12 1849 Cholera Map of St. Louis (Source:)

2.13 1850 Ward Boundaries (Source: St. Louis Genealogical Society)

2.14 1857 St. Louis County Topography Map by Gustavus Waagner  
(Source: Library of Congress, <https://www.loc.gov/resource/g4163s.la000406/>  
)

2.15 1860 Ward Boundaries (Source: St. Louis Genealogical Society)

2.16 1870 Ward Boundaries (Source: St. Louis Genealogical Society)

2.17 1871 Tracy Guide to St. Louis (Source: David Rumsey Map Collection)

2.18 1880 Ward Boundaries (Source: St. Louis Genealogical Society)

- 2.19 1882 R. A Campbell, Campbell's Revised Guide Map of St. Louis  
(Source: Norman B. Leventhal Map Center, Boston Public Library)
- 2.20 1884 Streetcars of St. Louis, (Source: Richard Mc Culloch: "Street  
Railway Cars in St Louis" *The Street Railway Journal* **XII:10** (1896.10):  
pl.ins.580-581)
- 2.21 1893 Rand McNally Map of St. Louis (Source: University of Missouri-St.  
Louis, Collection M-153)
- 2.22 1895 Mathews-Northrup Map of St. Louis (Source: David Rumsey Map  
Collection)
- 2.23 1900 Encyclopedia Britannica Map of St. Louis (Source: Encyclopedia  
Britannica: [https://www.britannica.com/place/Saint-Louis-Missouri/images-  
videos/Map-of-St-Louis-Missouri-US-from-the-10th-edition/51190](https://www.britannica.com/place/Saint-Louis-Missouri/images-videos/Map-of-St-Louis-Missouri-US-from-the-10th-edition/51190).)
- 2.24 1903 USGS Map of St. Louis (Source: Harvard Map Collection, Harvard  
College)
- 2.25 1904 Missouri-Illinois, Saint Louis Special Map, United State Geologic  
Service (Source: Norman B. Leventhal Map Center, Boston Public Library)

2.26 1907 Map of St. Louis City and County, James C. Travilla for St. Louis Civic League (Source: Norman B. Leventhal Map Center, Boston Public Library)

2.27 1921 Map of St. Louis City and Suburbs, H.W. Gross (Source: Norman B. Leventhal Map Center, Boston Public Library)

2.28 1923 George Cram Map of St. Louis (Source: University of Alabama Map Collection)

2.29 1937 Residential Security Map (Red Line) (Source: Harvard University, [http://worldmap.harvard.edu/data/geonode:holc\\_sl\\_1937\\_z12](http://worldmap.harvard.edu/data/geonode:holc_sl_1937_z12))

2.30 1937 St. Louis County Aerial Photography

2.31 1941 Map of St. Louis by Herman W. Gross, (Source: University of Missouri- St. Louis, Collection M-153)

2.32 1946 Zoning Map of St. Louis (Source: Washington University in St. Louis, University Libraries)

2.33 1947 Harland Bartholomew Plan (Source: City of St. Louis Planning and Urban Design Agency)

2.34 1950 St. Louis Zoning Map (Source: City of St. Louis Planning and Urban Design Agency)

2.35 1955 St. Louis County Aerial Photography (Source: St. Louis County GIS Department)

2.36 1956 Shell Map of St. Louis (Source: David Rumsey Map Collection)

2.37 Eliot Plan for North St. Louis Expressway

2.38 1966 St. Louis County Aerial Photography (Source: St. Louis County GIS Department)

2.39 1970-72 St. Louis County Aerial Photography (Source: St. Louis County GIS Department)

2.40 1974 Slope Map of St. Louis, (Source: City of St. Louis, Planning and Urban Design Agency))

2.41 1981 St. Louis County Aerial Photography (Source: St. Louis County GIS Department)

2.42 1984 Rand McNally Map of St. Louis (Source:)

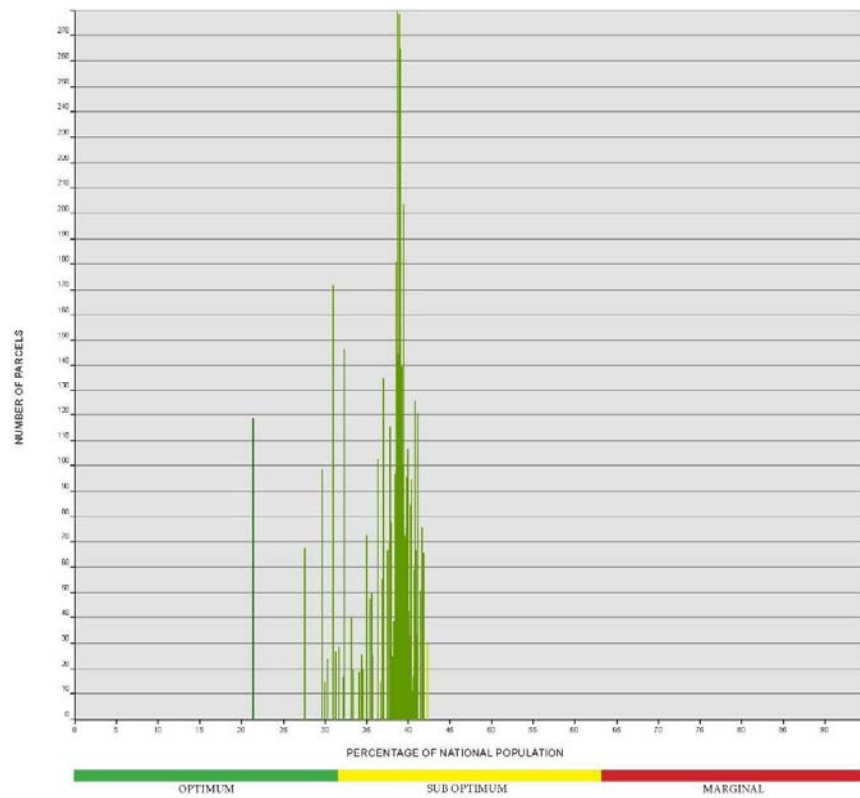
2.43 1995-97 St. Louis County Aerial Photography (St. Louis County GIS Department and Google Earth Engine, 2016)

- 2.44 2000 St. Louis County Aerial Photography (Google Earth Engine, 2016)
- 2.45 2002 St. Louis County Aerial Photography (Google Earth Engine, 2016)
- 2.46 2004 St. Louis County Aerial Photography (Google Earth Engine, 2016)
- 2.47 2006 St. Louis County Aerial Photography (Google Earth Engine, 2016)
- 2.48 2008 St. Louis County Aerial Photography (Google Earth Engine, 2016)
- 2.49 2010 St. Louis County Aerial Photography (Google Earth Engine, 2016)
- 2.50 2016 St. Louis County Aerial Photography (Google Earth Engine, 2016)

### E3: Additional Maps and Charts:

The following graphs illustrate the distribution of vacant land parcels by habitat quality in New Orleans and St. Louis.

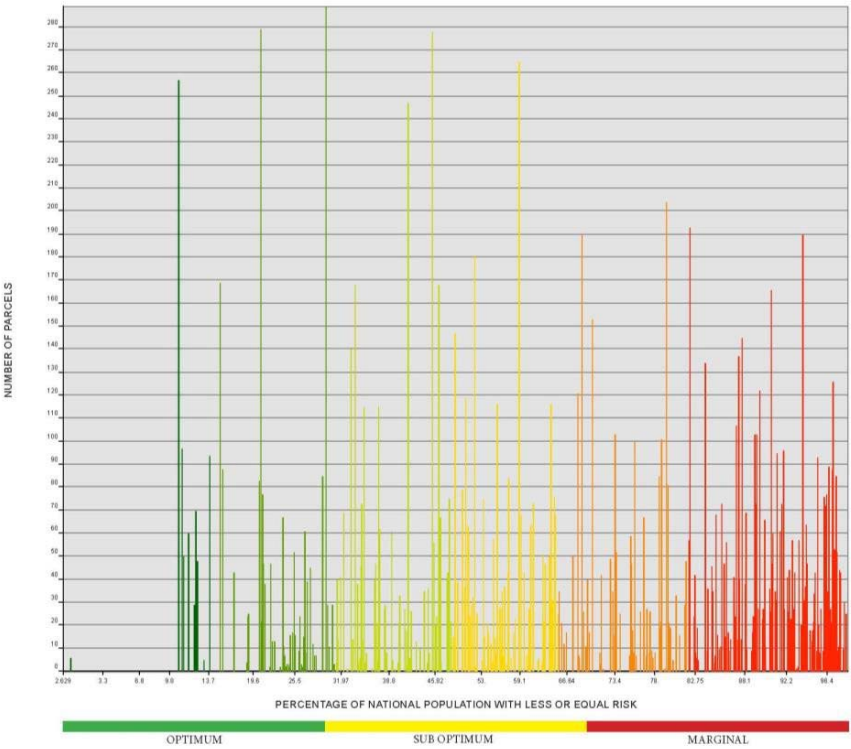
Land Vacancy and PM 2.5 in New Orleans



Vacant Lands and DSLPM Risk in New Orleans



Vacant Parcels and Traffic to New Orleans



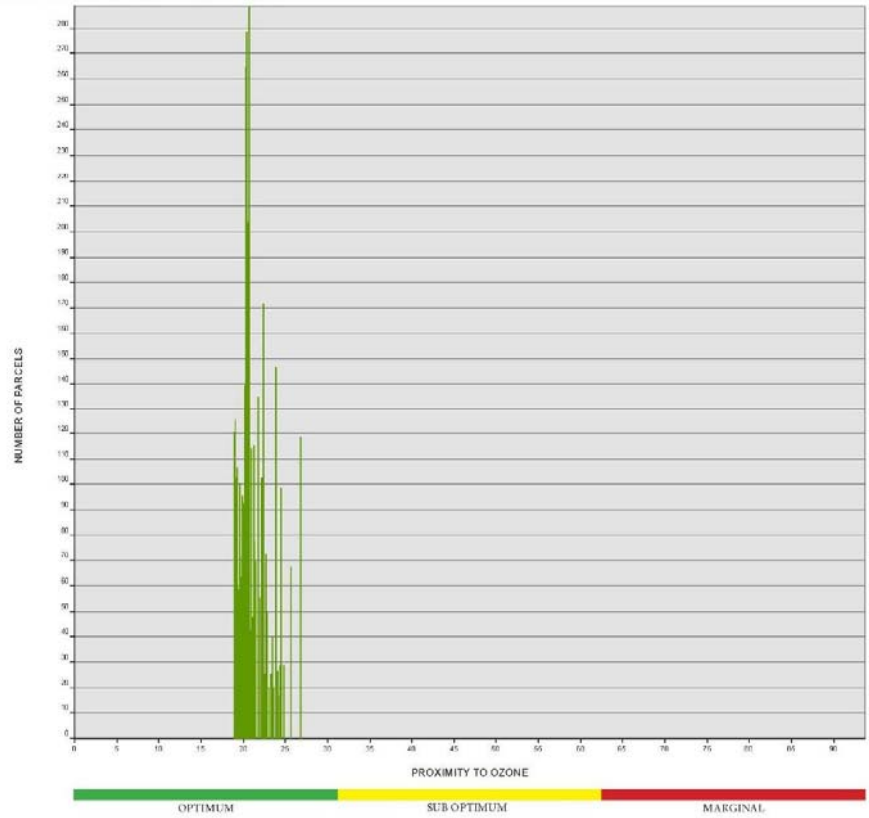
Vacant Lands and NPL Risk in New Orleans



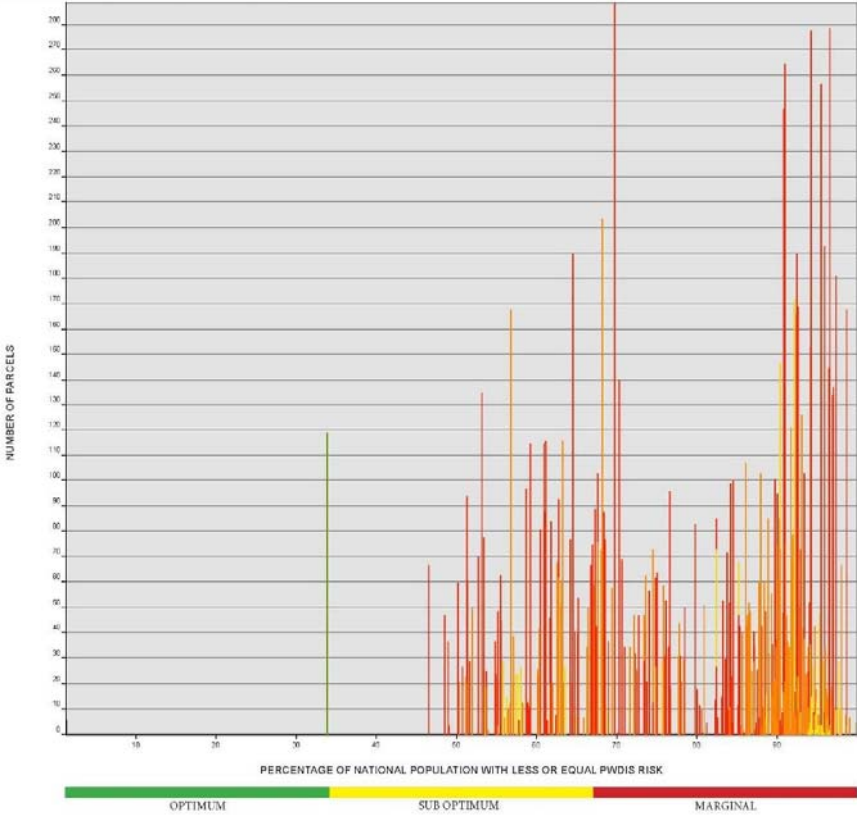




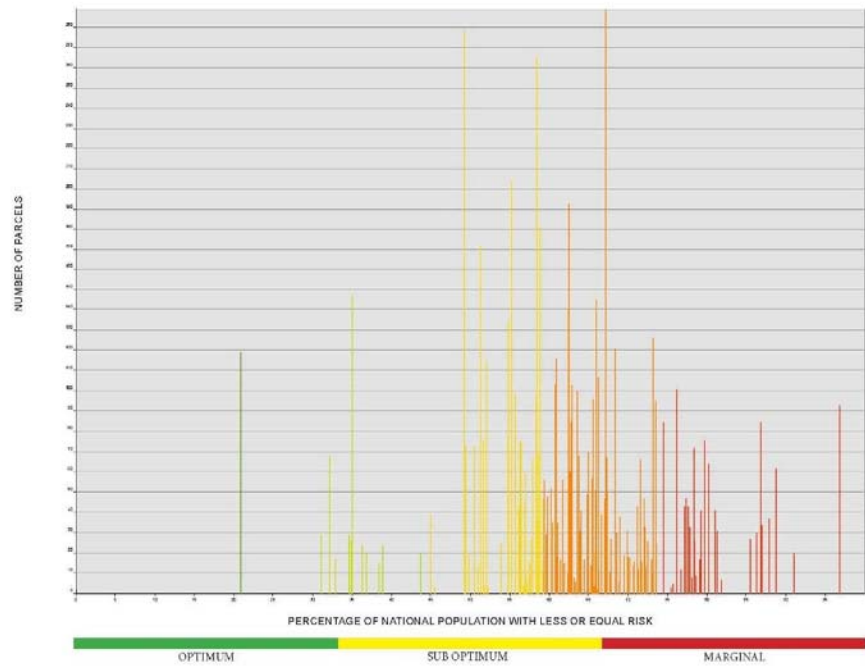
### Vacant Lands and Ozone Risk in New Orleans



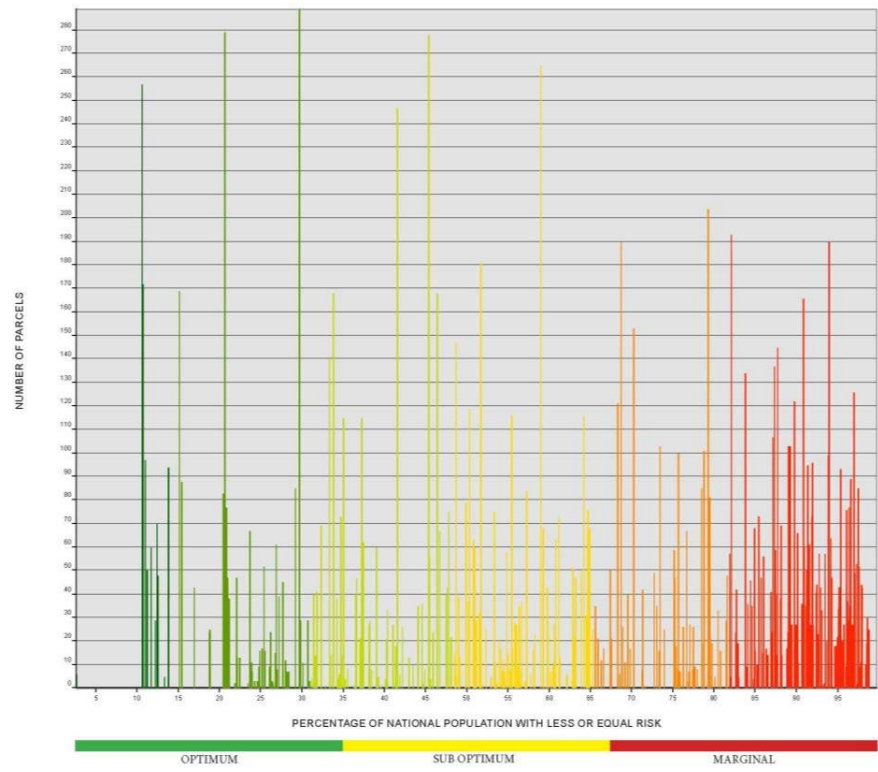
Vacant Lands and PWDIS Risk in New Orleans



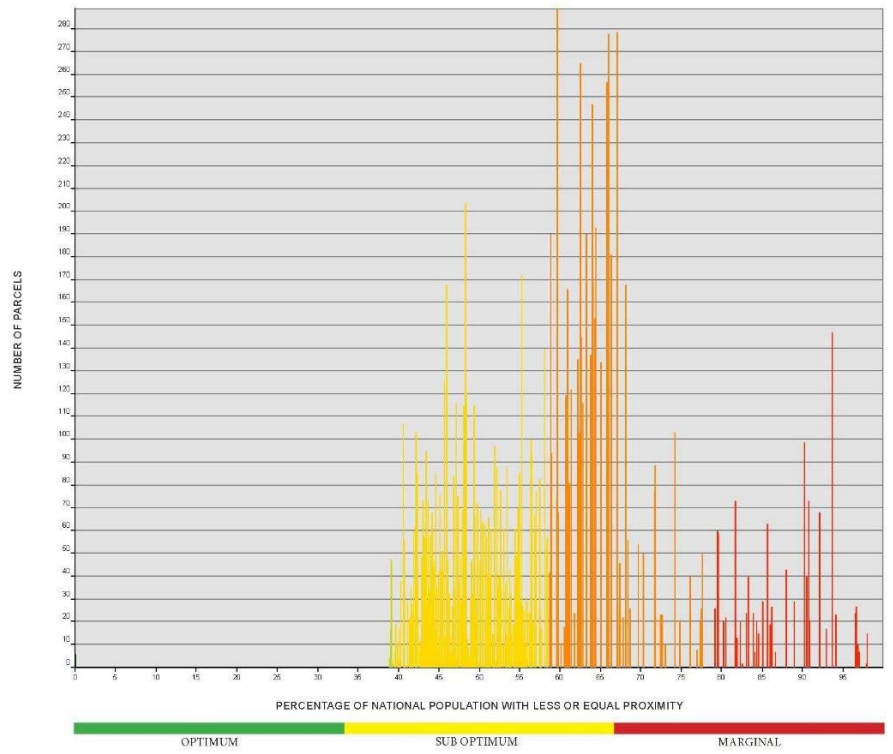
# Vacant Lands and Respiratory Risk in New Orleans



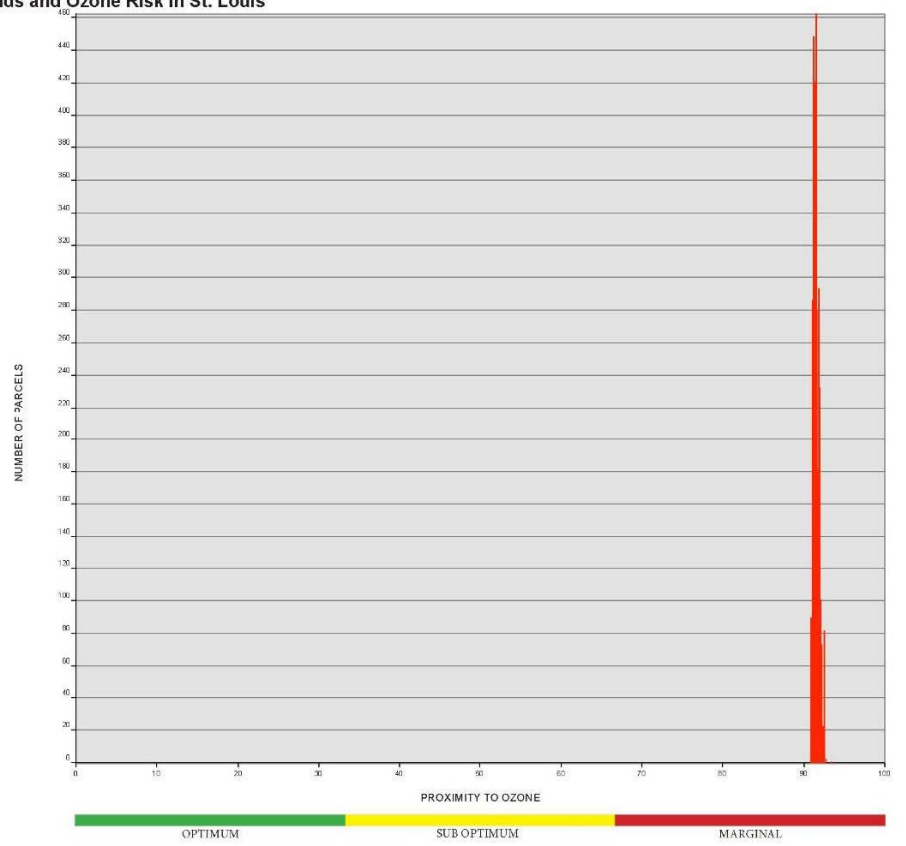
# Vacant Parcels and Traffic in New Orleans



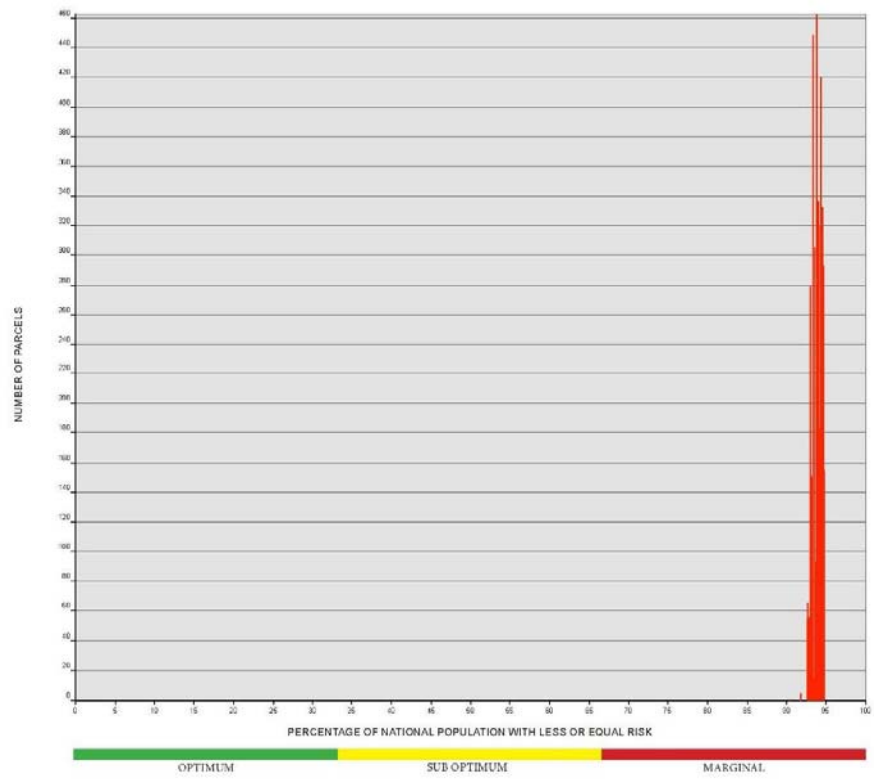
# Vacant Parcels and Proximity to Waste Management Facilities in New Orleans



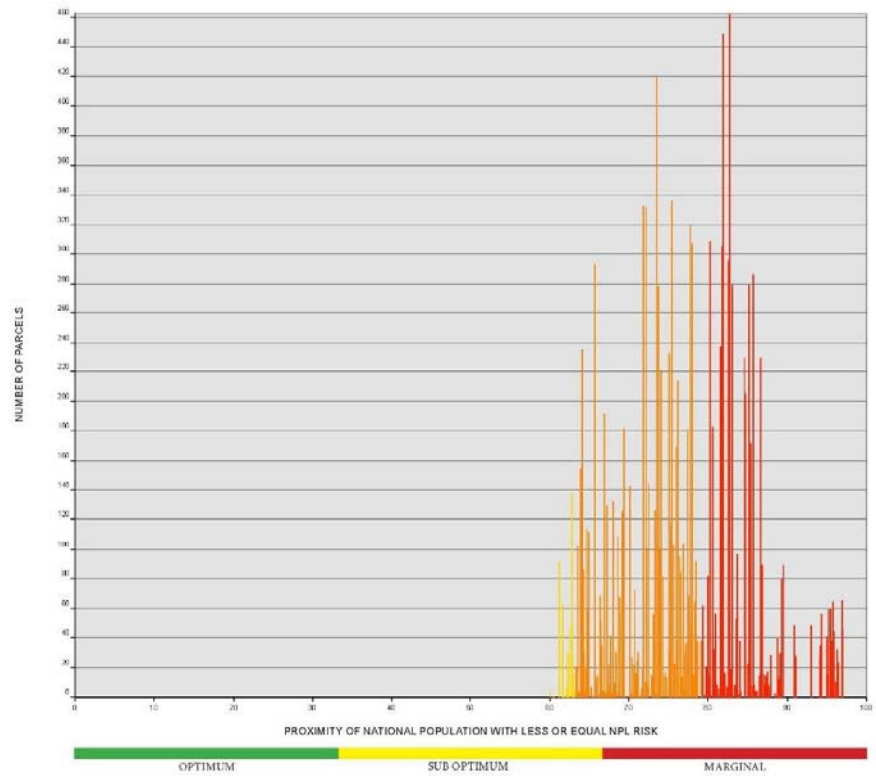
### Vacant Lands and Ozone Risk in St. Louis



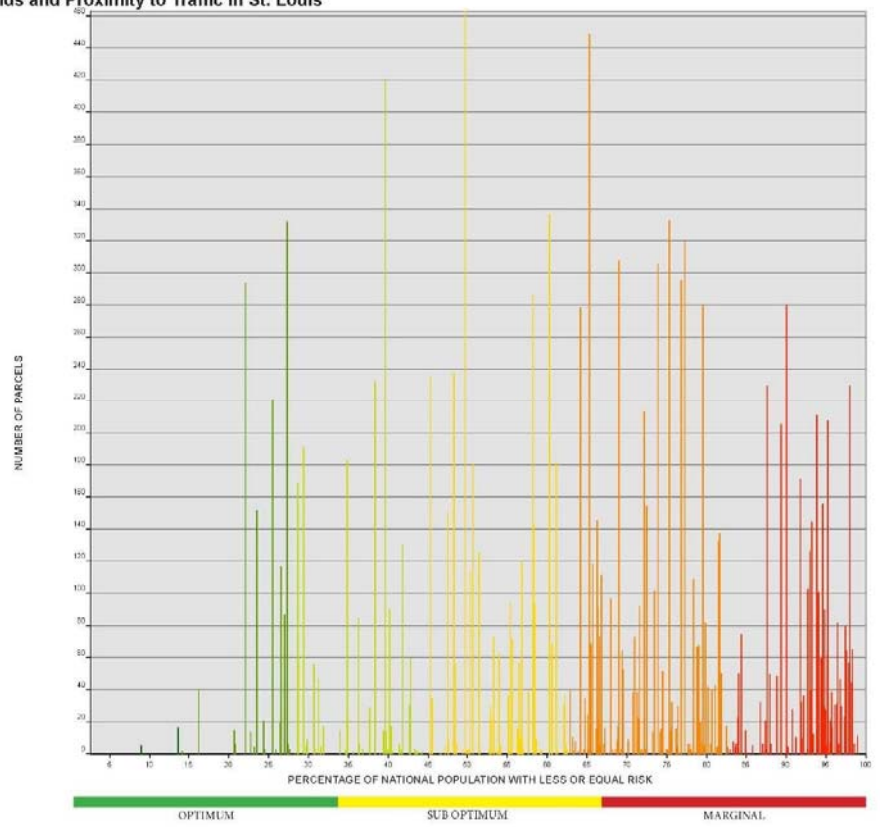
### Vacant Lands and PM 2.5 Risk in St. Louis



### Vacant Lands and NPL Risk in St. Louis

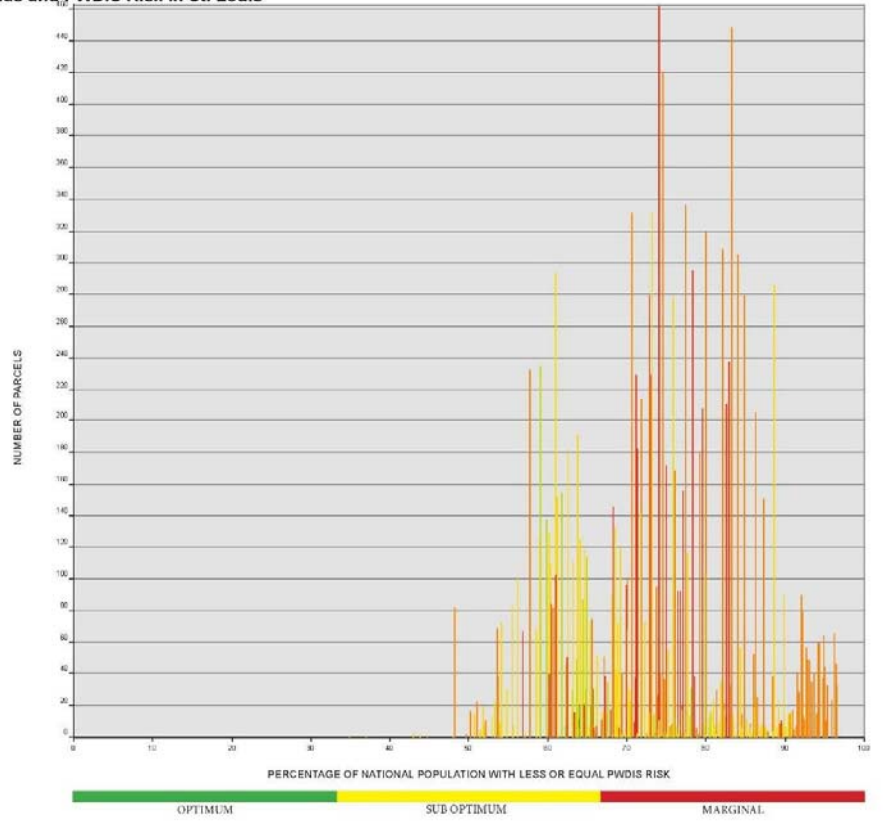


Vacant Lands and Proximity to Traffic in St. Louis

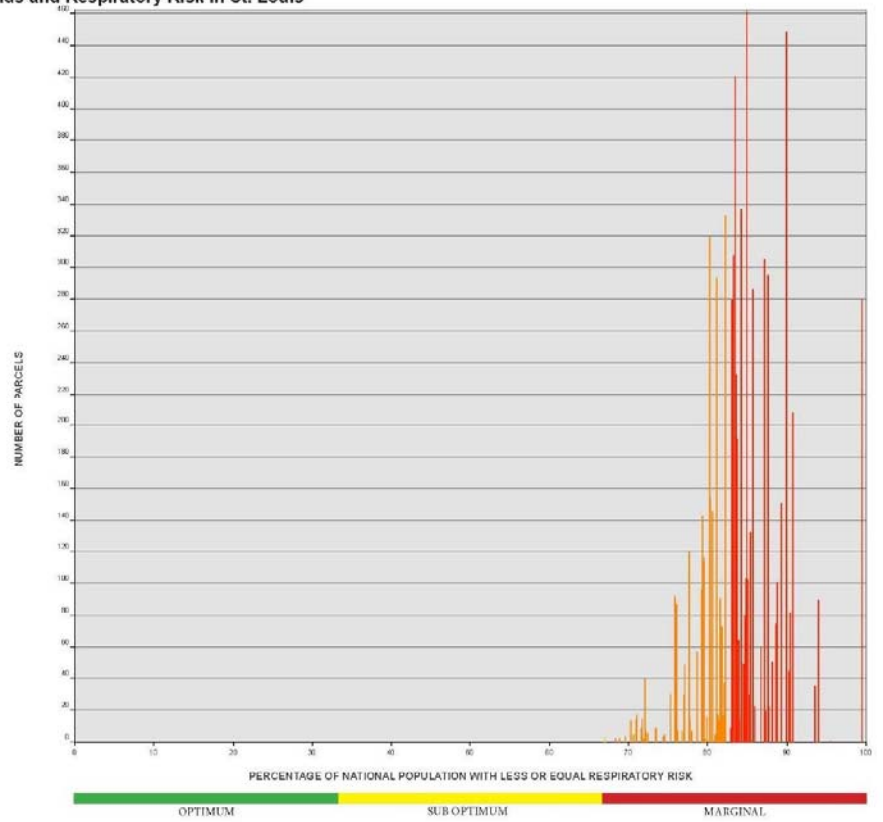




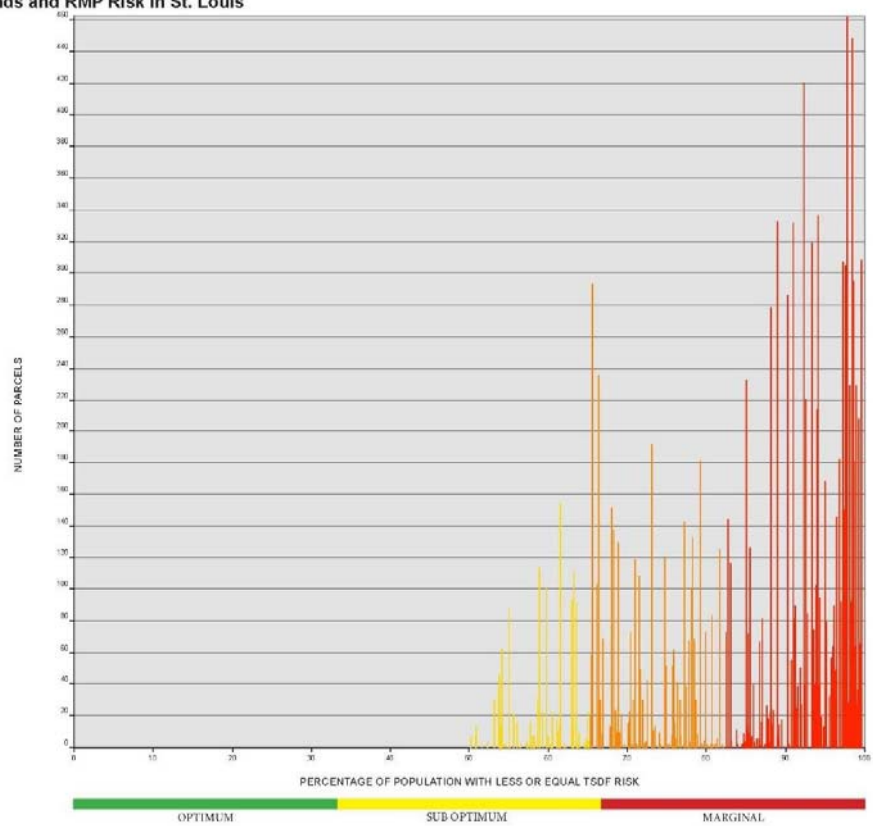
**Vacant Lands and PWDIS Risk in St. Louis**



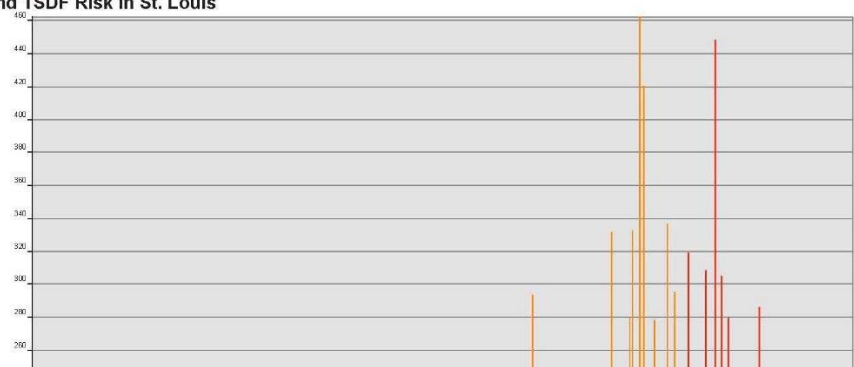
### Vacant Lands and Respiratory Risk in St. Louis



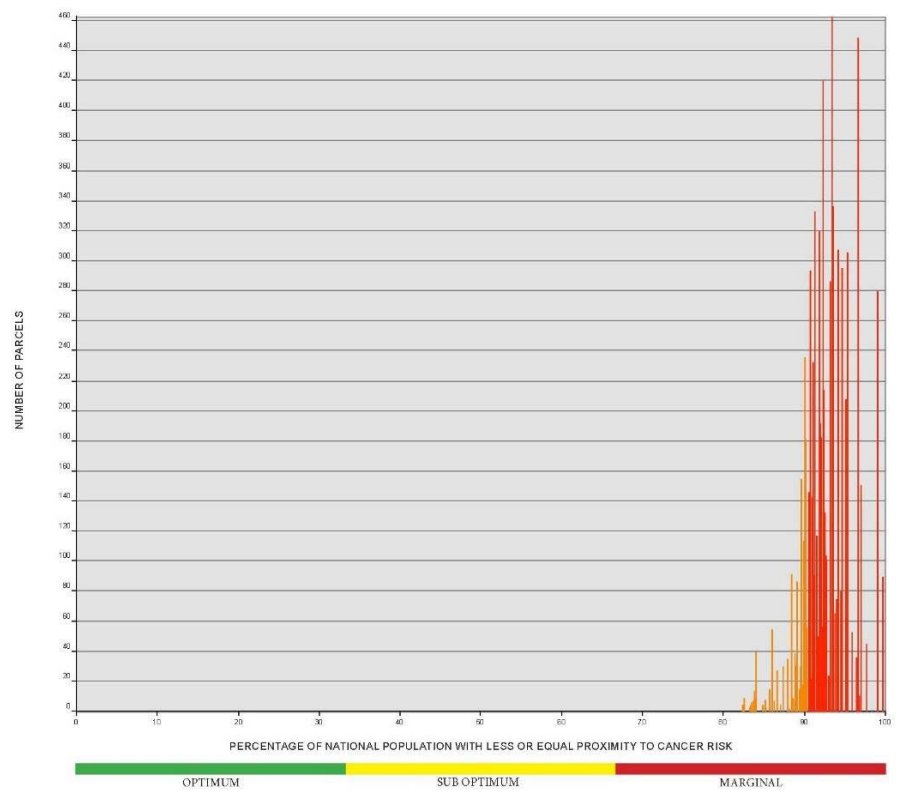
**Vacant Lands and RMP Risk in St. Louis**



**Vacant Lands and TSD Risk in St. Louis**



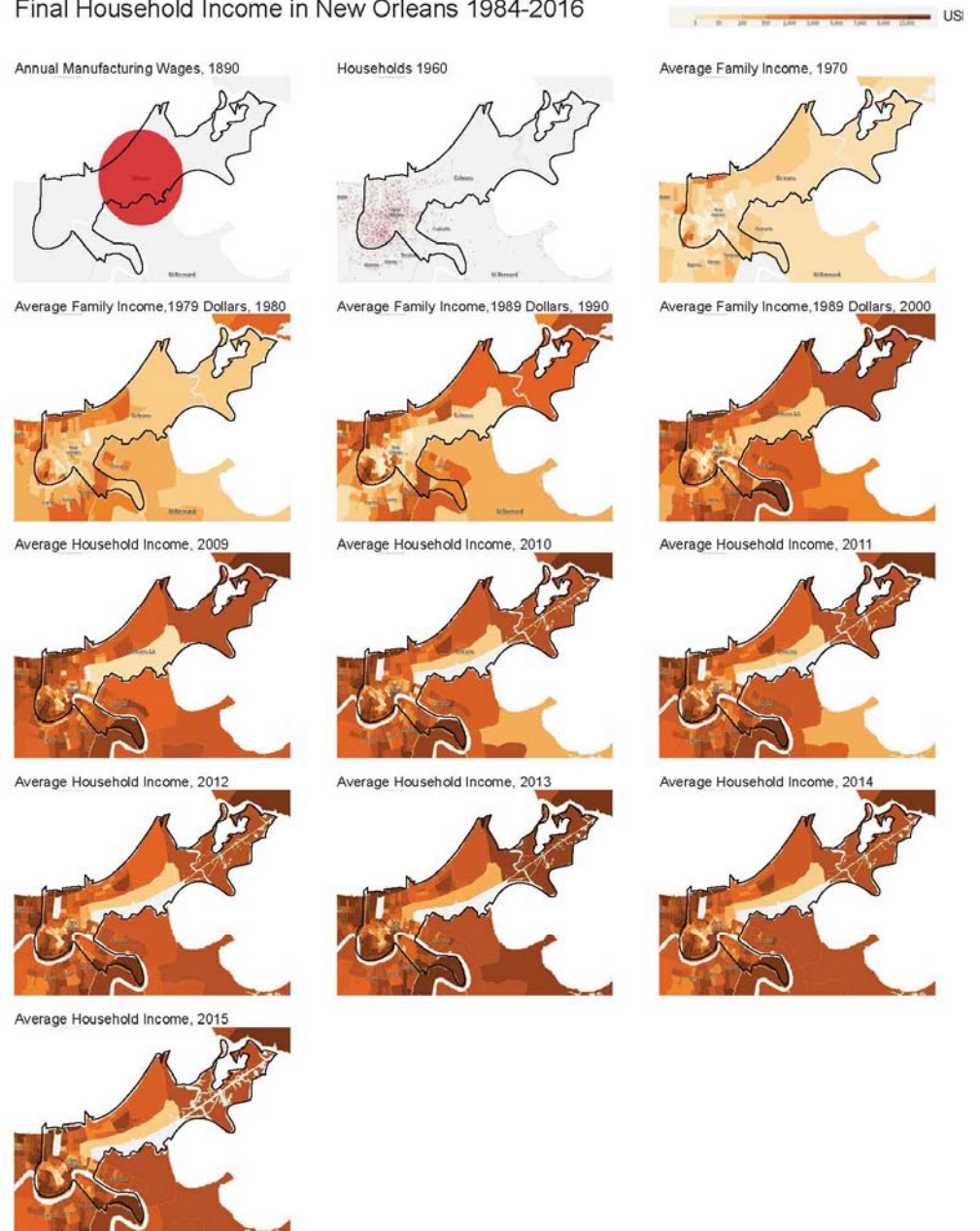
### Vacant Lands and Cancer Risk in St. Louis



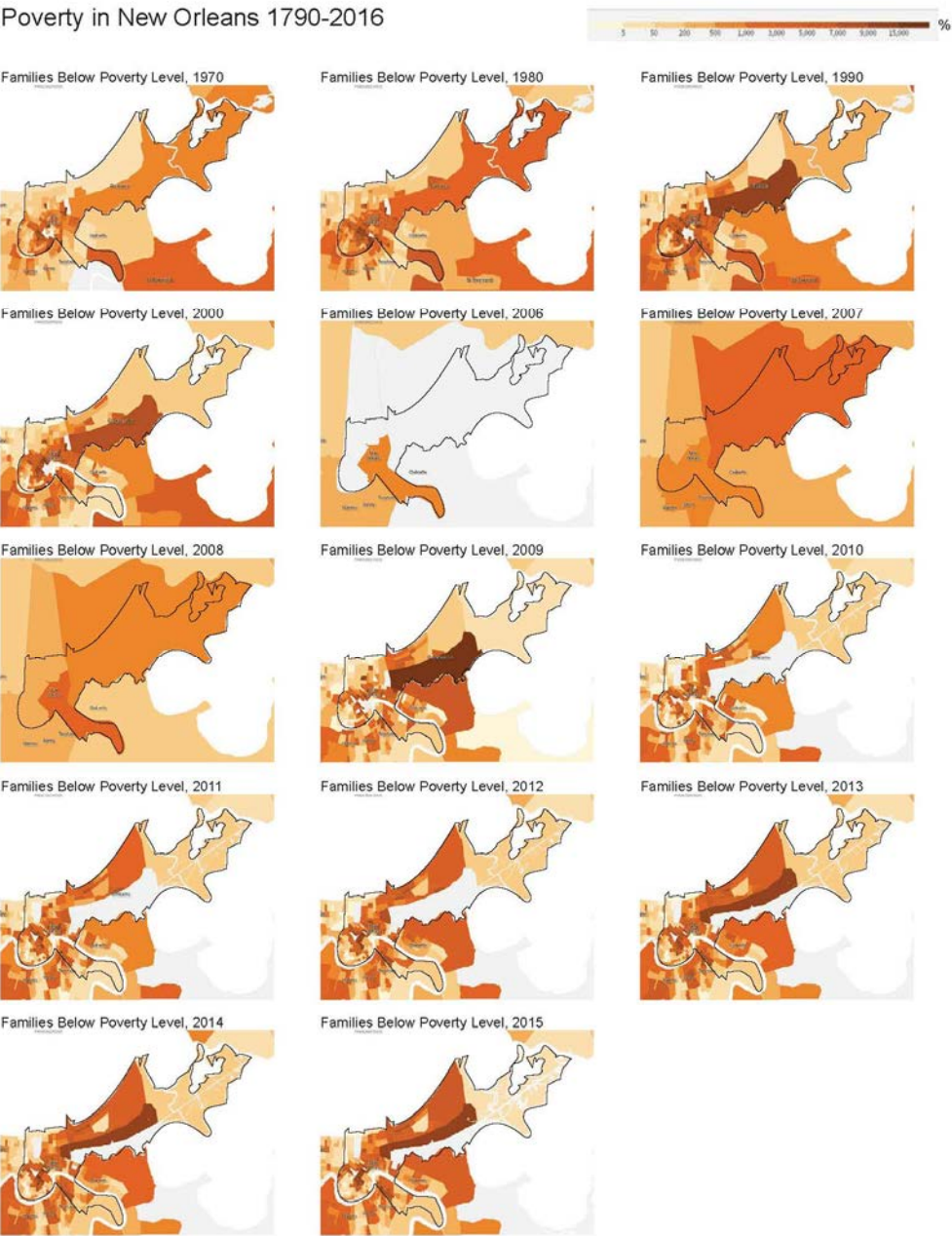
## E4: Time Lapse Sequences

The following time series sequences illustrate the movement and persistence of patches across the New Orleans and St. Louis landscape.

Final Household Income in New Orleans 1984-2016

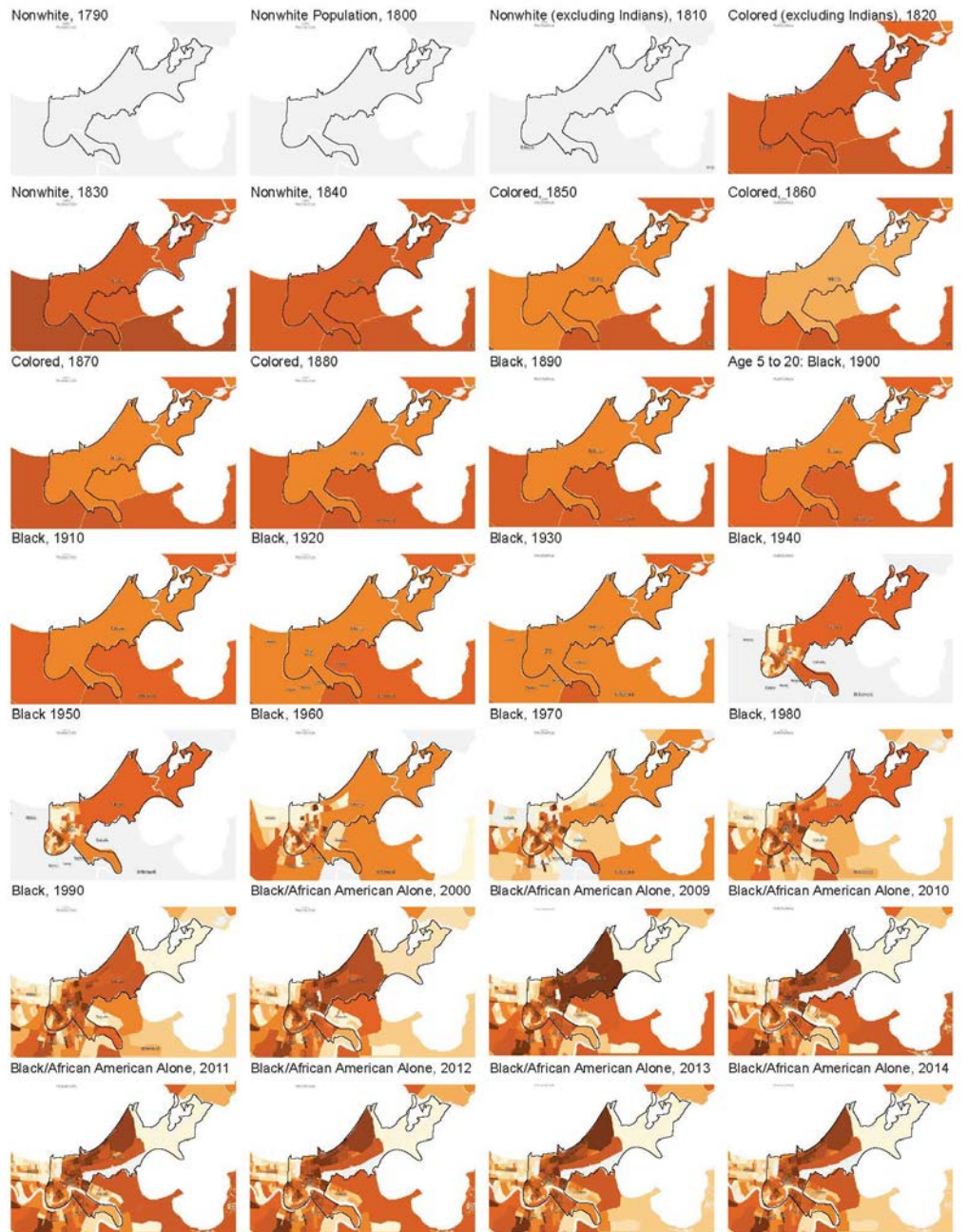


Poverty in New Orleans 1790-2016

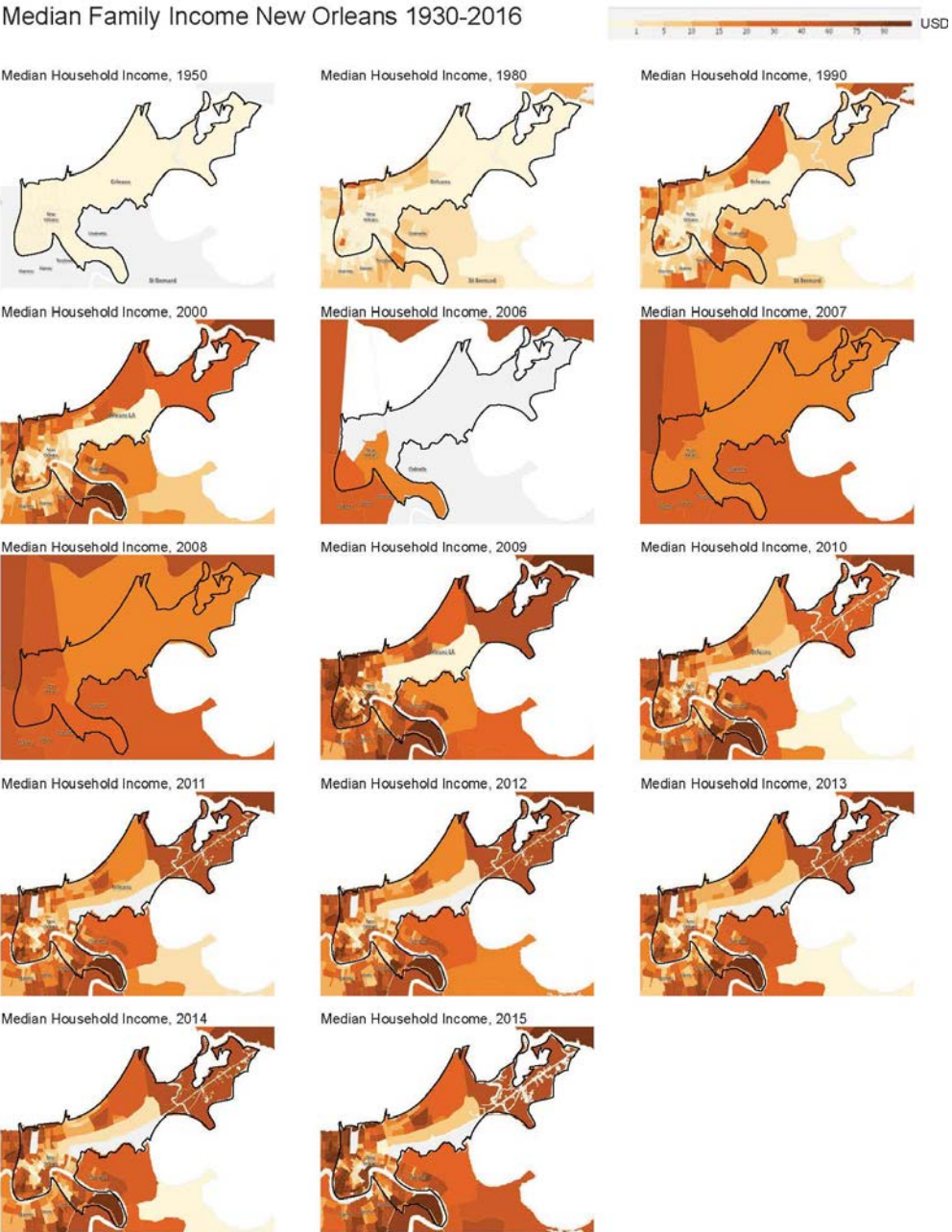




# African American Population New Orleans 1790-2016



Median Family Income New Orleans 1930-2016





Unemployment in New Orleans 1930-2016



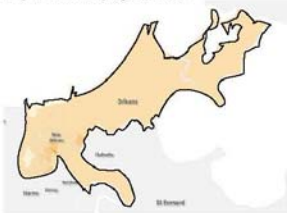
Registered Fully Unemployed, 1930



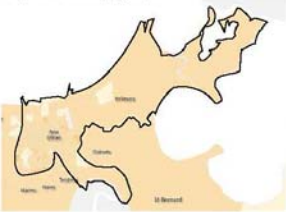
Pop 14+ Unemployed, 1940



Pop 14+ Unemployed, 1950



Pop 14+ Unemployed, 1960



Pop 16+ Unemployed, 1970



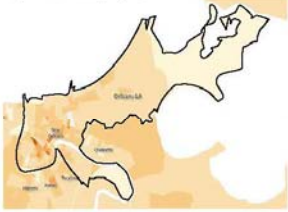
Pop 16+ Unemployed, 1980



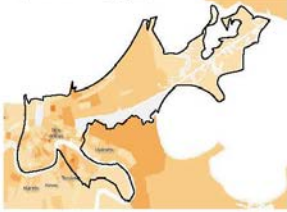
Pop 16+ Unemployed, 1990



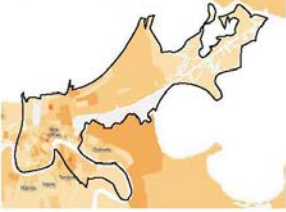
Pop 16+ Unemployed, 2000



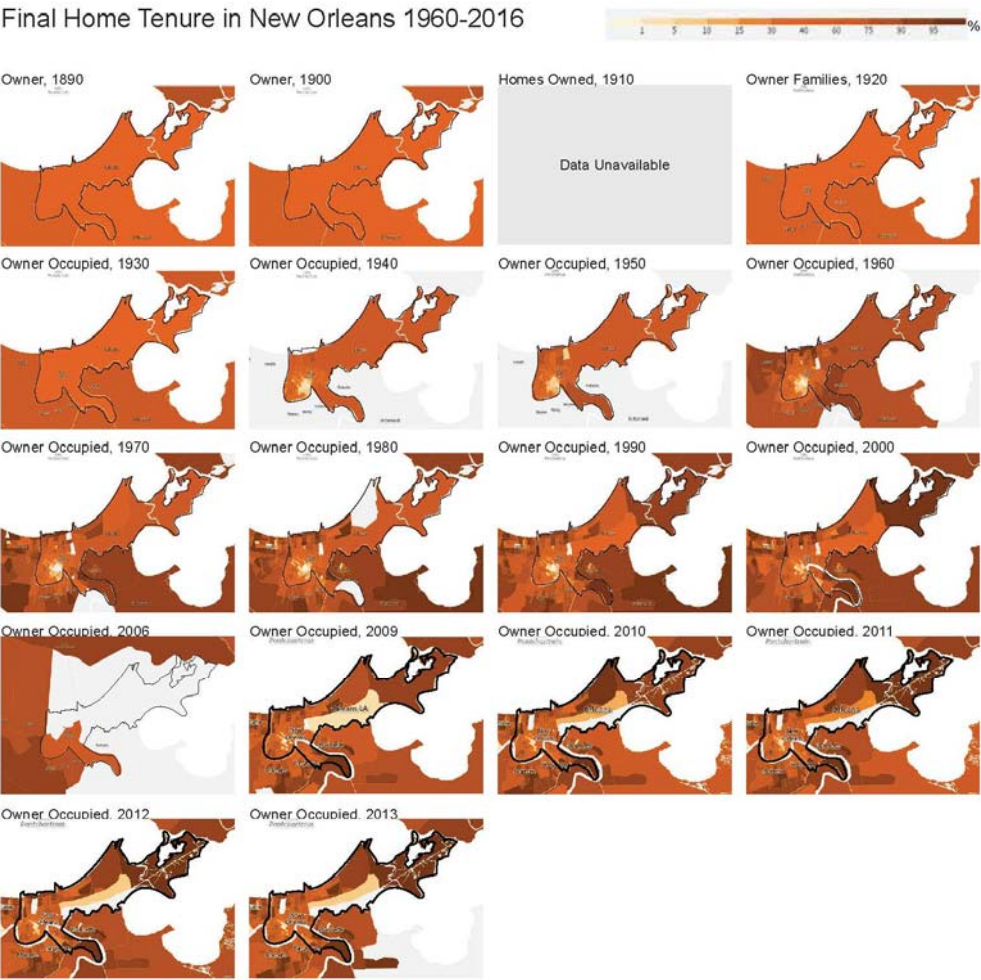
Pop 16+ Unemployed, 2015



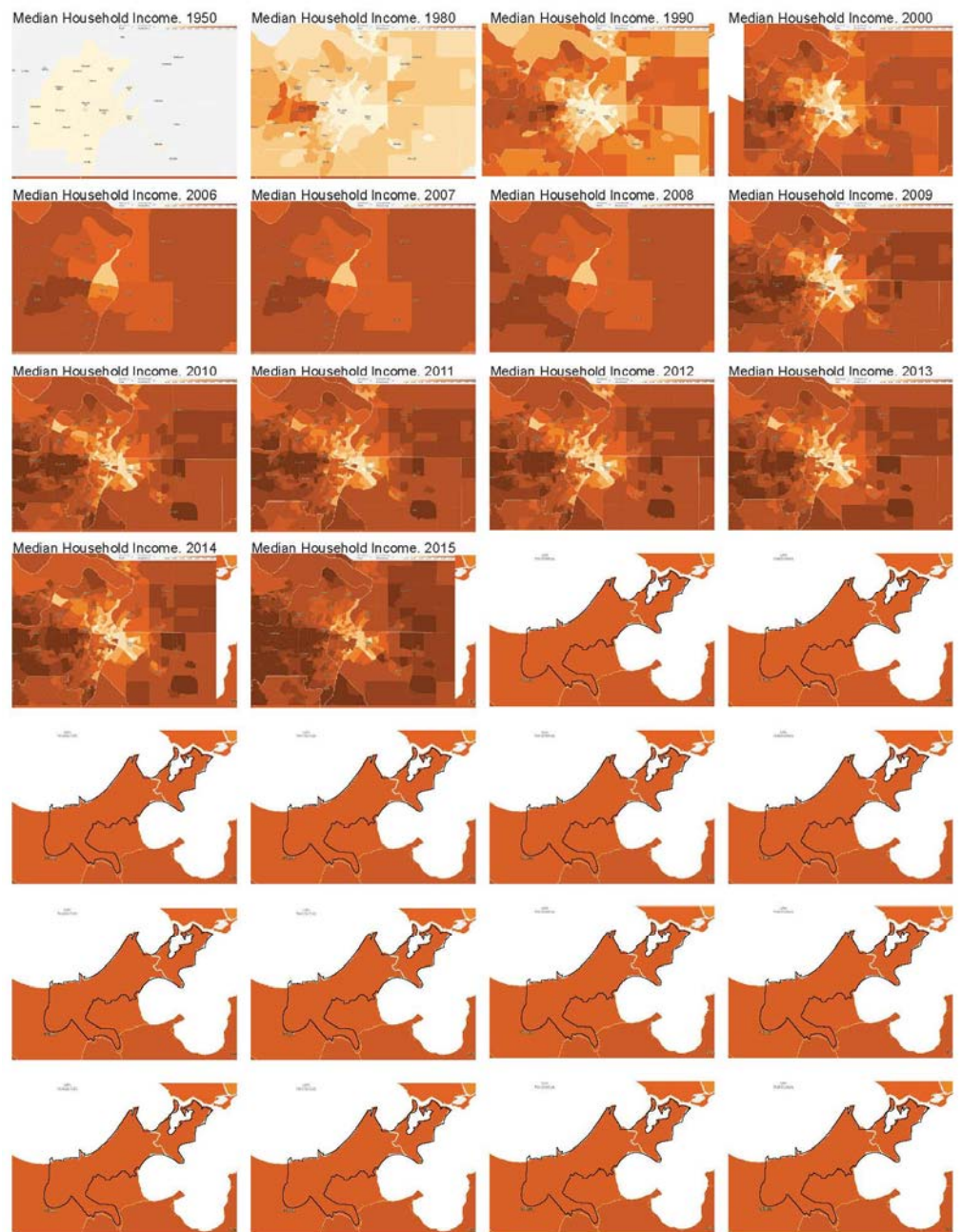
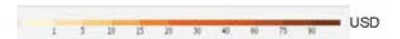
Pop 16+ Unemployed, 2015



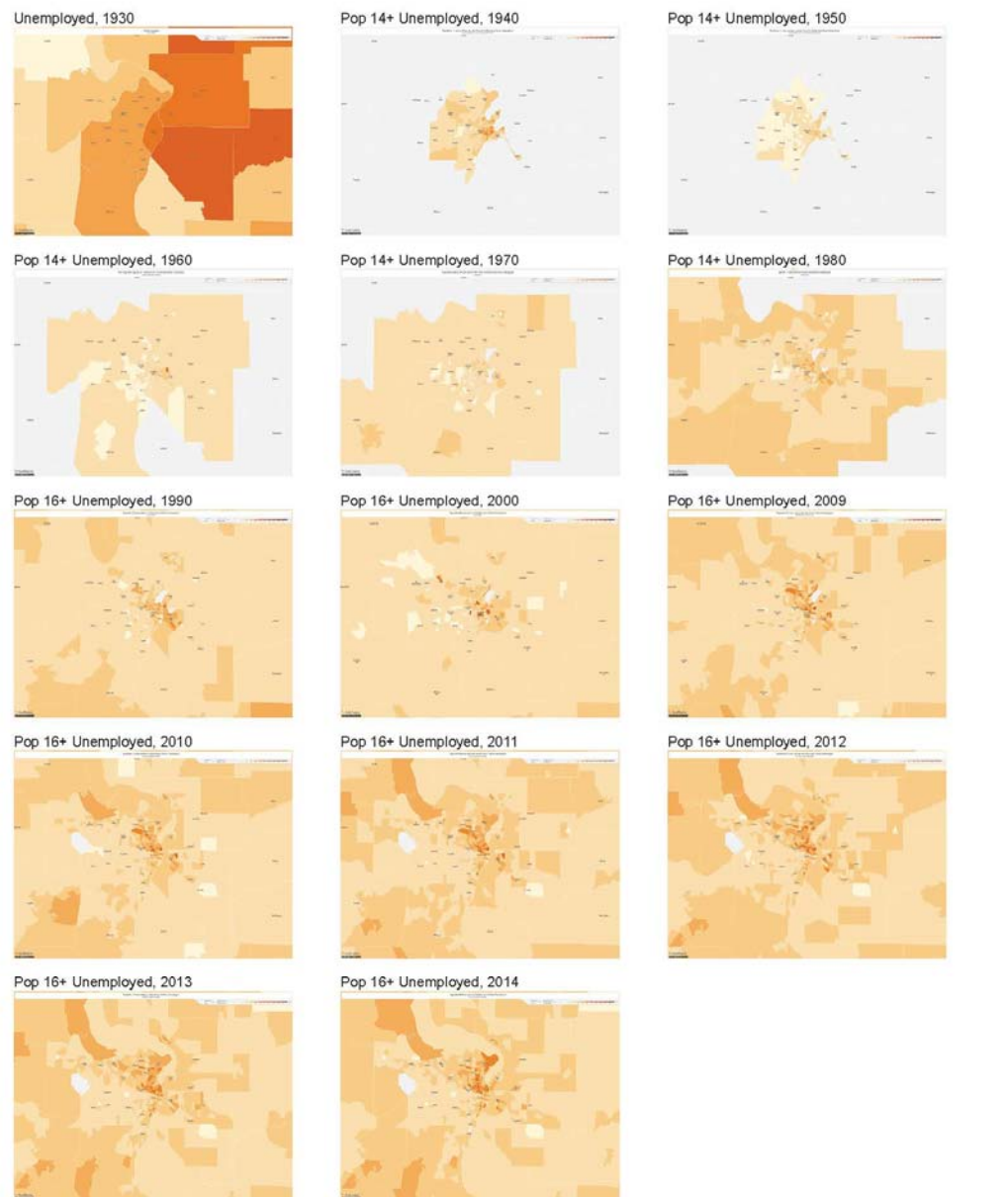
Final Home Tenure in New Orleans 1960-2016



# Median Family Income St. Louis 1930-2016



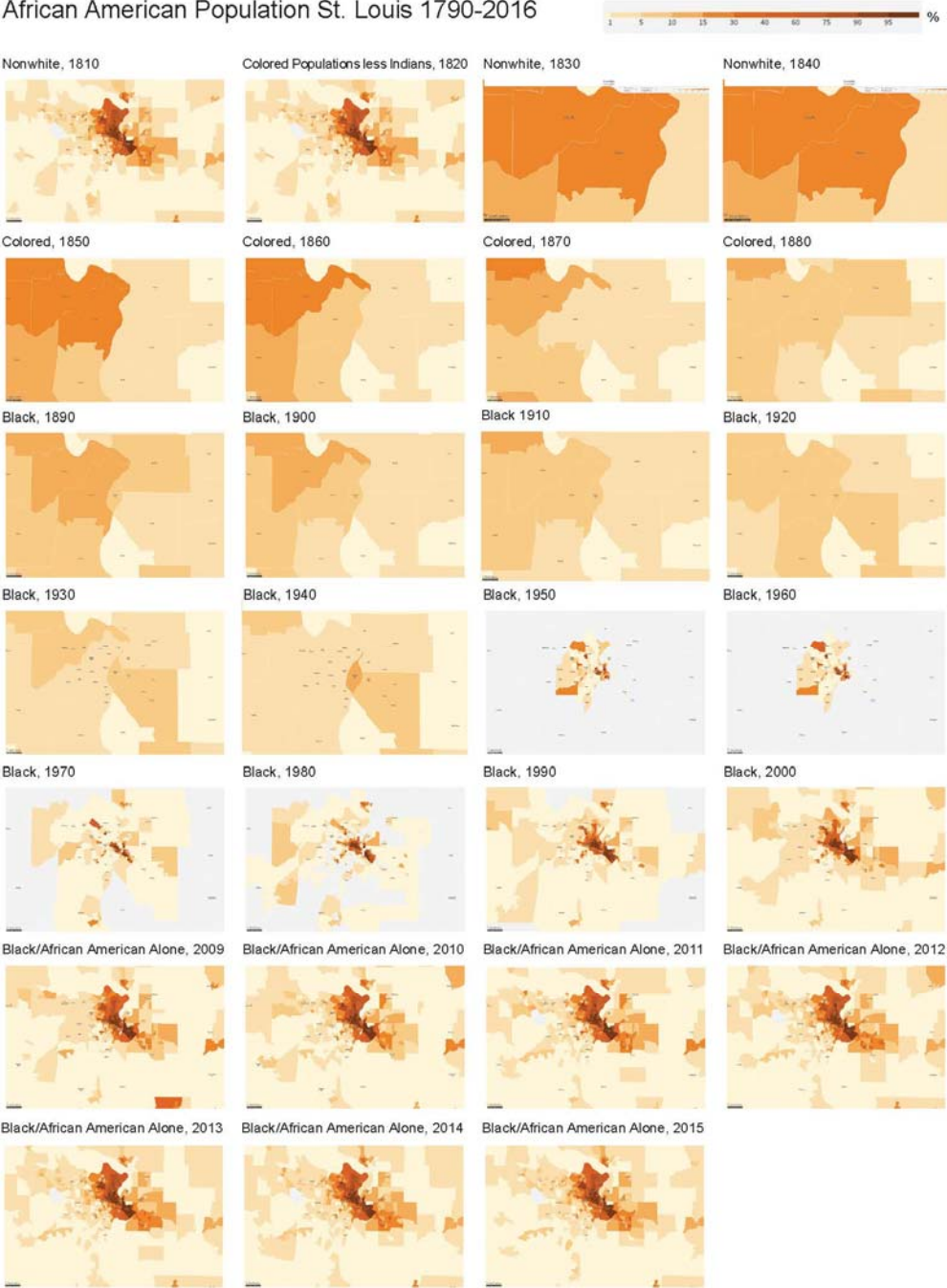
## Unemployment in St. Louis 1930-2016





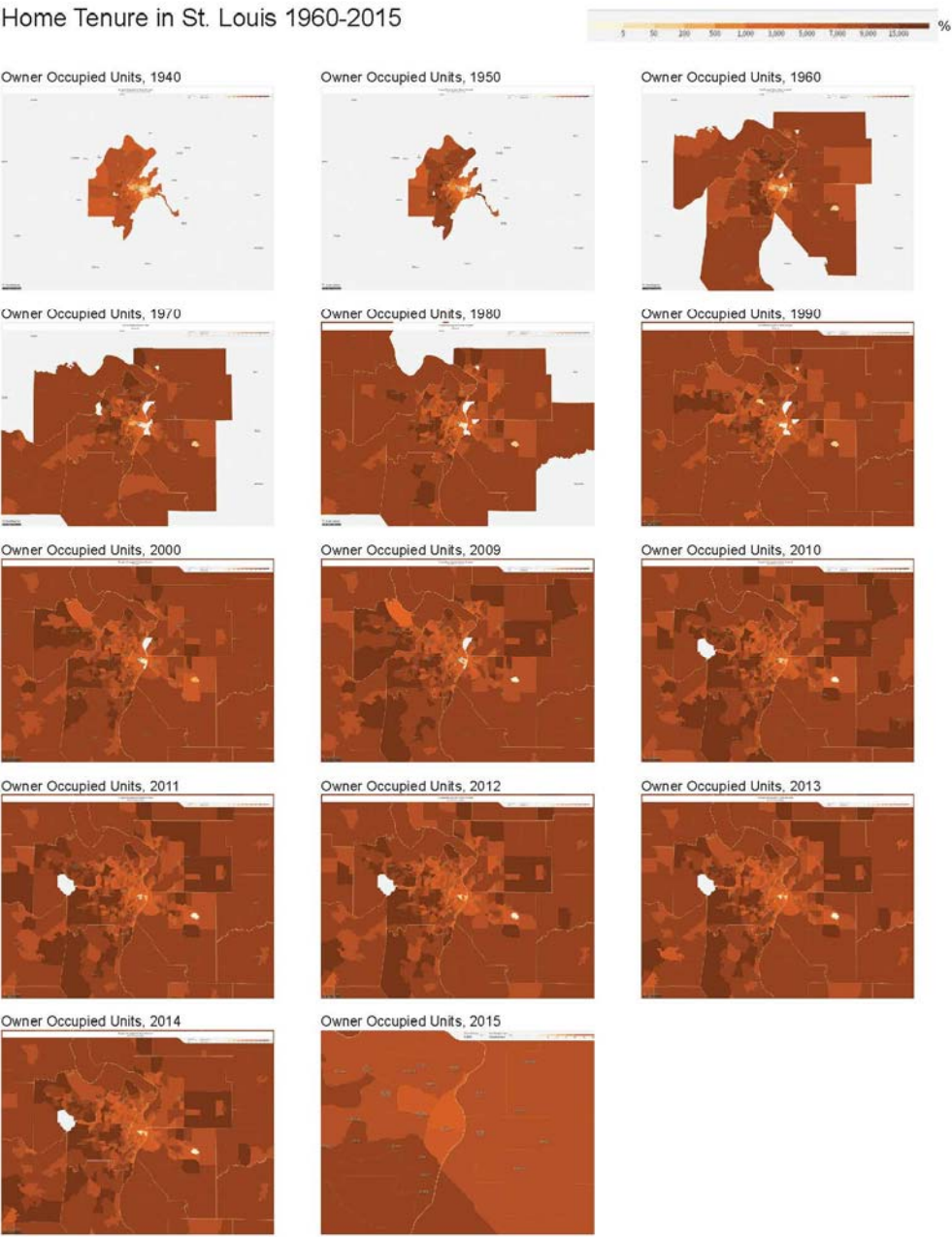


African American Population St. Louis 1790-2016



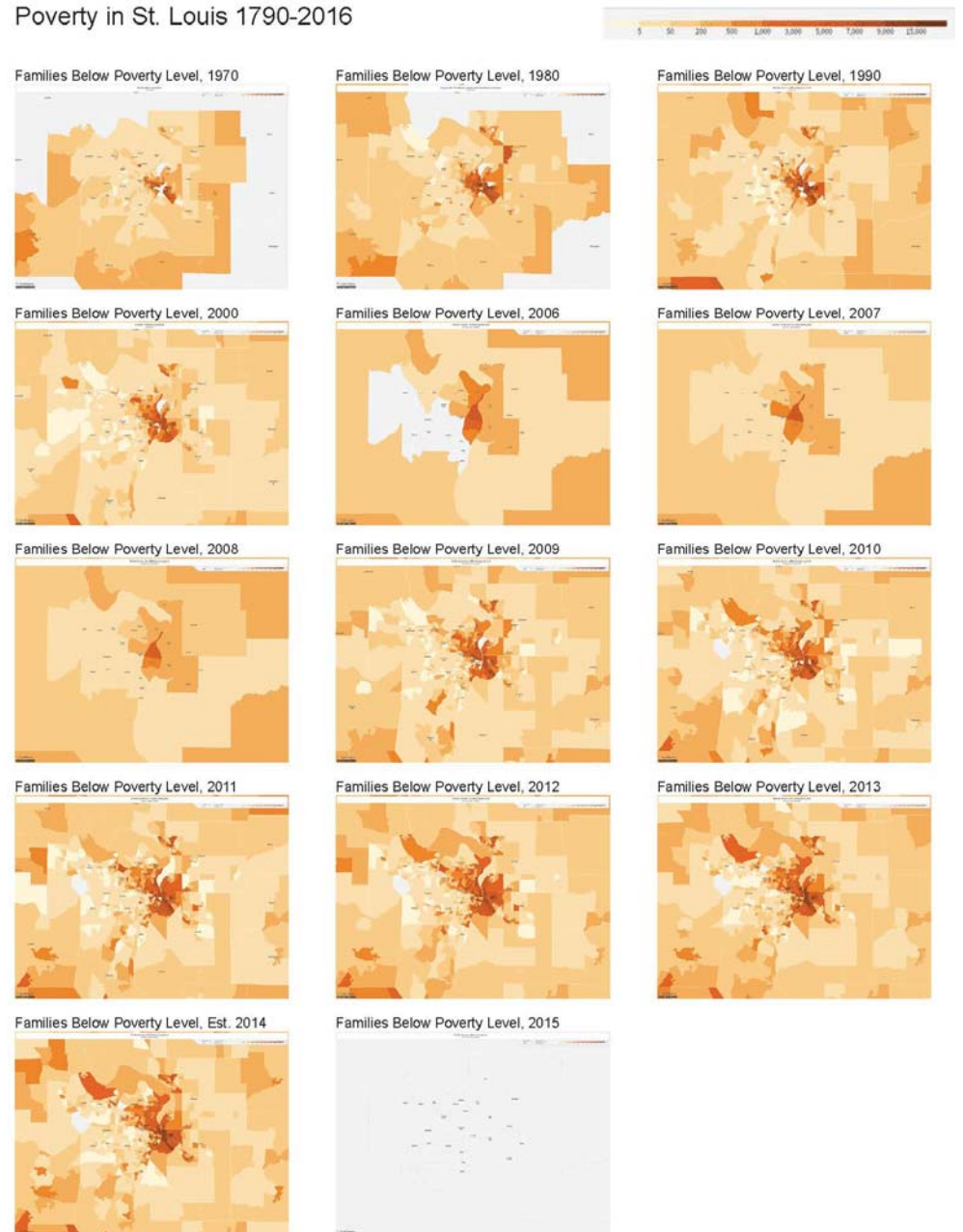


Home Tenure in St. Louis 1960-2015

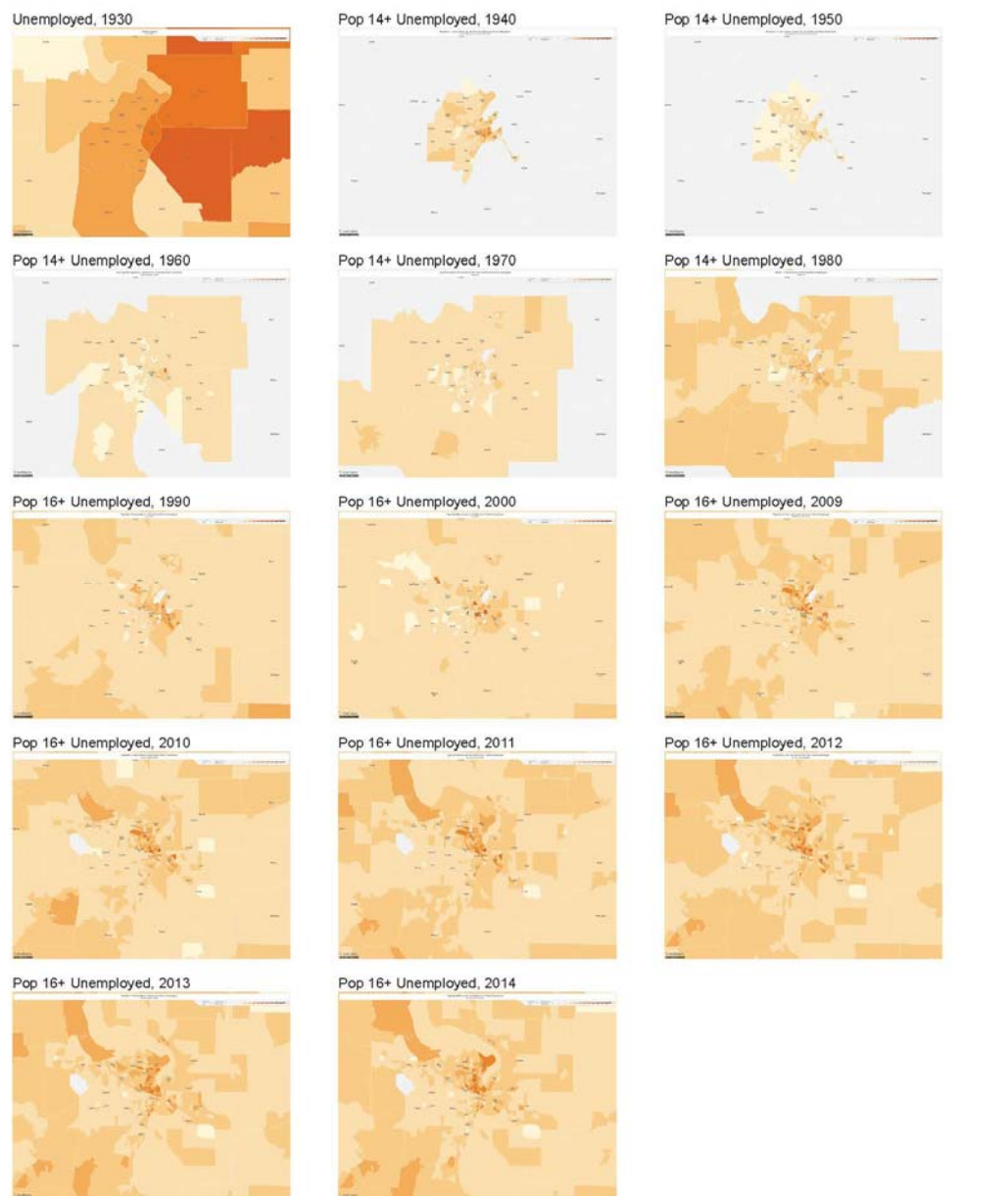




## Poverty in St. Louis 1790-2016



## Unemployment in St. Louis 1930-2016



## Median Family Income St. Louis 1930-2016

